

# *DÆDALUS*



PROCEEDINGS OF THE  
AMERICAN ACADEMY OF ARTS AND SCIENCES, *Boston.*  
VOLUME 86 · 1955-1957



050  
D13

## CONTENTS

Number 1 May 1955

A Foreword to Dædalus, by Walter Muir Whitehill	3
Dædalus, by David McCord	6
Catalogue of H (II) Regions in the Milky Way, by Bart J. Bok, Michiel J. Bester and Campbell M. Wade	9
Physical Problems of Photosynthesis, Rumford Medal Lecture 1955, by James Franck	17
Count Rumford on Photosynthesis, by Sanborn C. Brown	43
Publishing the Papers of Great Men, by Walter Muir Whitehill, Julian P. Boyd, Leonard W. Labaree, L. H. Butterfield, Wil- marth S. Lewis, and Waldo G. Leland	47
Art as the Function of an Audience, by Johannes A. Gaertner	80
Records of Meetings from October 1954 to March 1955	94
Documents	100

Number 2 September 1956

Foreword, by Walter Muir Whitehill	107
A Farewell to the Academy House on Newbury Street, by Harlow Shapley	110
Science and the Whole Man, by Caryl P. Haskins	113
Rembrandt the Draughtsman, by Jakob Rosenberg	122
Records of Meetings from April to December 1955	137
Documents	167

Number 3 May 1957

Foreword, by Walter Muir Whitehill	171
Imperium Sine Fine, by John E. Burchard	174
Man, Beast, and Field, by Terence Millin	190
A Liberal Education and the Advancement of American Free- dom, by Harold R. Medina	206
Franklin in France, by Morris Bishop	214
Benjamin Franklin and the Armonica, by E. Power Biggs	231
The Chinese Painter, by Chiang Yee	242
Records of Meetings from January to May 1956	253

## *CONTENTS*

Number 4 October 1957

Foreword, by Walter Muir Whitehill	283
The Archaic Smile, by Francis Henry Taylor	285
Thermal Convection, Rumford Medal Lecture 1957, by S. Chandrasekhar	323
Count Rumford Discovers Thermal Convection, by Sanborn C. Brown	340
Anthropology and Film, by Robert Gardner	344

## *Index of Papers by Author and Title*

- Adams, John, letter of 15 October 1786, 168.  
*Adams Papers, The*, by L. H. Butterfield, 62-71.  
*Anthropology and Film* by Robert Gardner, 344-352.  
*Archaic Smile, The Relation of Art and the Dignity of Man, The*, by Francis Henry Taylor, 285-322.  
*Art as the Function of an Audience* by Johannes A. Gaertner, 80-93.  
*Benjamin Franklin and the Armonica* by E. Power Biggs, 231-241.  
Bester, Michiel J., *see* Bok, Bart J.  
Biggs, E. Power, *Benjamin Franklin and the Armonica*, 231-241.  
Bishop, Morris, *Franklin in France*, 214-230.  
Bok, Bart J., Bester, Michiel J. and Wade, Campbell M., *Catalogue of H (II) Regions in the Milky Way For Longitudes 250°-355°*, 9-16.  
Boyd, Julian P., *Some Animadversions on Being Struck by Lightning*, 49-56.  
Brown, Sanborn C., *Count Rumford Discovers Thermal Convection*, 340-343.  
Brown, Sanborn C., *Count Rumford on Photosynthesis*, 43-46.  
Burchard, John E., *Imperium Sine Fine*, 174-189.  
Butterfield, L. H., *The Adams Papers*, 62-71.  
*Catalogue of H (II) Regions in the Milky Way For Longitudes 250°-355°* by Bart J. Bok, Michiel J. Bester and Campbell M. Wade, 9-16.  
Chandrasekhar, S., *Thermal Convection* (Rumford Medal Lecture 1957), 323-339.  
Chiang Yee, *The Chinese Painter*, 242-252.  
*Chinese Painter, The*, by Chiang Yee, 242-252.  
Copley, John Singleton, letter of October 1786, 167-168.  
*Count Rumford Discovers Thermal Convection* by Sanborn C. Brown, 340-343.  
*Count Rumford on Photosynthesis* by Sanborn C. Brown, 43-46.  
*Dædalus* by David McCord, 6-8.  
*Documents*, letters from George Washington and Albert Schweitzer, 100-102; letters from John Singleton Copley and John Adams, 166-167.

- Editing Familiar Letters* by Wilmarth S. Lewis, 71-77.
- Farewell to the Academy House on Newbury Street, A*, by Harlow Shapley, 110-112.
- Forewords* by Walter Muir Whitehill, 3-5, 107-109, 171-173, 283-284.
- Franck, James, *Physical Problems of Photosynthesis* (Rumford Medal Lecture 1955), 17-42.
- Franklin in France* by Morris Bishop, 214-230.
- Gaertner, Johannes A., *Art as the Function of an Audience*, 80-93.
- Gardner, Robert, *Anthropology and Film*, 344-352.
- Haskins, Caryl P., *Science and the Whole Man*, 113-121.
- Imperium Sine Fine* by John E. Burchard, 174-189.
- Labaree, Leonard W., *The Papers of Benjamin Franklin*, 57-62.
- Leland, Waldo G., *Remarks in Publishing the Papers of Great Men, A Session at the Sixty-Ninth Annual Meeting of the American Historical Association, 30 December 1954*, 77-79.
- Liberal Education and the Advancement of American Freedom, A*, by Harold R. Medina, 206-213.
- Lewis, Wilmarth S., *Editing Familiar Letters*, 71-77.
- Man, Beast and Field, Some Influence of the Francis Amory Prize Researches* by Terence Millin, 190-205.
- McCord, David, *Dædalus*, 6-8.
- Medina, Harold R., *A Liberal Education and the Advancement of American Freedom*, 206-213.
- Millin, Terence, *Man, Beast and Field, Some Influence of the Francis Amory Prize Researches*, 190-205.
- Papers of Benjamin Franklin, The*, by Leonard W. Labaree, 57-62.
- Physical Problems of Photosynthesis* (Rumford Medal Lecture 1955) by James Franck, 17-42.
- Publishing the Papers of Great Men, A Session at the Sixty-Ninth Annual Meeting of the American Historical Association, 30 December 1954*, by Walter Muir Whitehill, Julian P. Boyd, Leonard W. Labaree, L. H. Butterfield, Wilmarth S. Lewis and Waldo G. Leland, 47-79.
- Remarks* by Waldo G. Leland, 77-79.
- Rembrandt the Draughtsman with Consideration of the Problem of Authenticity* by Jakob Rosenberg, 122-136.

Rosenberg, Jakob, *Rembrandt the Draughtsman with Consideration of the Problem of Authenticity*, 122-136.

Schweitzer, Albert, letters of 15 December 1954 and 28 January 1955, 101-103.

*Science and the Whole Man* by Caryl P. Haskins, 113-121.

Shapley, Harlow, *A Farewell to the Academy House on Newbury Street*, 110-112.

*Some Animadversions on Being Struck by Lightning* by Julian P. Boyd, 49-56.

Taylor, Francis Henry, *The Archaic Smile, The Relation of Art and the Dignity of Man*, 285-322.

*Thermal Convection* (Rumford Medal Lecture 1957) by S. Chandrasekhar, 323-339.

Wade, Campbell M., *see* Bok, Bart J.

Washington, George, letter of 22 March 1781, 100.

Whitehill, Walter Muir, *Foreword to Publishing the Papers of Great Men, A Session at the Sixty-Ninth Annual Meeting of the American Historical Association, 30 December 1954*, 47-49.

Whitehill, Walter Muir, *Forewords*, 3-5, 107-109, 171-173, 283-284.

### *Index to Affairs of the American Academy of Arts and Sciences*

Annual meeting, 1955, 138-163; 1956, 257-280.

Appropriations, 137, 258.

Assessment, annual, 137, 257.

#### Committees:

Amory Prize, 139, 163-164, 165; Report of, 153, 272.

Franklin 250th Anniversary, 95, 139, 253-254, 256-257.

House, Report of, 154-155, 272-273.

Permanent Science Fund, 94, 98, 163, 165.

Grants, 156-158, 273-276; Report of, 155-158, 273-276.

Publication, 95, 165; Report of, 158-160, 277-278.

Quarters, 138, 139, 165-166.

Rumford, 96, 98, 99, 137, 165; Award of 1955 Premiums, 96, 99;

Medal Lectures, 17-42, 323-339; Report of, 160-162, 278-280.

Committees — *Continued*

School Science, 258.

Warren, C. M., 139; Report of, 162-163, 280.

Council, 98, 165.

*Dædalus*, 3-5, 95, 159-160.

Elections, Fellows and Honorary Members, 141-145, 260-264.

Officers and Committees, 145-146, 264-265.

Fellows: Deaths, 141, 259; Elected, 141-144, 260-263.

Introductions, 94, 96, 97, 98, 99, 138, 163, 164, 166, 254, 255.

Resignations, 141; Transfer of Status, 141, 260.

Ford, Horace Sayford, Retirement of, 140, 163.

Foreign Honorary Members: Deaths, 141, 260.

Elected, 144-145, 263-264.

Franklin 250th Anniversary, 95, 139, 171-173, 214-241, 253-254, 256-257.

House of the Academy, 99, 188-109, 138, 139.

Meetings, Records of, 94-99, 137-166, 253-280.

Officers and Committees: 1955-56, 145-146; 1956-57, 264-265.

Records of Meetings, 94-99, 137-166, 253-280.

Reports, *see* under respective officers, committees, etc.

Rumford Committee, *see* Committees, Rumford.

Sale of Newbury Street house, 99, 138, 139.

Seal, 95.

Statutes, Revision of, 94, 95-96, 139, 163, 165, 254.

Treasurer, Report of, 147-152, 266-271.

# DÆDALUS

---

Proceedings of the American Academy of Arts and Sciences

---

## CONTENTS

A FOREWORD TO <i>Dædalus</i> , by Walter Muir Whitehill	3
DÆDALUS, by David McCord	6
CATALOGUE OF H(II) REGIONS IN THE MILKY WAY, by Bart J. Bok, Michiel J. Bester and Campbell M. Wade	9
PHYSICAL PROBLEMS OF PHOTOSYNTHESIS, Rumford Medal Lecture 1955, by James Franck	17
COUNT RUMFORD ON PHOTOSYNTHESIS, by Sanborn C. Brown	43
PUBLISHING THE PAPERS OF GREAT MEN, by Walter Muir Whitehill, Julian P. Boyd, Leonard W. Labaree, L. H. Butterfield, Wilmarth S. Lewis, and Waldo G. Leland	47
ART AS THE FUNCTION OF AN AUDIENCE, by Johannes A. GAERTNER	80
RECORDS OF MEETINGS	94
DOCUMENTS	100

MAY 1955 VOL. 86, NO. 1

AMERICAN ACADEMY OF ARTS AND SCIENCES

28 Newbury Street, Boston 16, Mass.

## THE COMMITTEE ON PUBLICATION

WALTER MUIR WHITEHILL, *Chairman*

HARLOW SHAPLEY

HUDSON HOAGLAND

ERWIN D. CANHAM

RUDOLPH RUZICKA

Editorial correspondence should be addressed to Walter Muir Whitehill, Editor, 10½ Beacon Street, Boston 8, Massachusetts.

## A Foreword to *Dædalus*

IN a prefatory note to their 1934 edition of the Reverend Jared Eliot's *Essays upon field husbandry in New England*, Professors Harry J. Carman and Rexford G. Tugwell portrayed a type of mind that must have been common among the eighteenth century founders of the American Academy of Arts and Sciences. "There used to be a kind of man," they wrote, "found rather often in earlier generations, who stood to a whole countryside as the representative there of learning. He might be a doctor or a lawyer; sometimes he was a craftsman; at any rate his ubiquitous interest in things of the mind made him notable. Men of this sort have a tendency now to flock together and, having done that, they specialize and develop a fantastic exclusiveness. This spoils the unique quality of the village philosopher. For this kind of man had an interest in all the branches of knowledge: archaeology, geology, astronomy — none of the sciences excluded him. Likely enough he had a chemical laboratory in the woodshed; and it was far from strange if his wife should catch him, on cold winter nights, gazing at the stars through a long brass telescope, he being meanwhile all too thinly protected from the weather. Perhaps his hobby was to discover the burial places of earlier inhabitants and to lay Indians' bones bare to the weather on some local hillside. He may have been the local atheist, his bent for learning taking a theological cast and he being by temperament contentious; or he may have been the schoolmaster interested to test for himself the conclusions which seemed too easily reached in books; then again he may have been the minister with interests other than those which were strictly legitimate to his profession, so that the things of this world came rather distinctly into Sunday discourse. It did not seem effrontery in earlier years to combine one's interests in this way; it has come to seem so now. But what has been gained in precision of scholarship and in depth of knowledge is certainly partly offset by a loss in breadth of interest and in speculative temper."

The Charter of Incorporation granted to the American Academy of Arts and Sciences by the Massachusetts Legislature on 4 May 1780, after listing many particular instances, summarized the "end and design" of the Academy as "to cultivate every art and science which may tend to advance the interest, honor, dignity, and happiness of a free, independent, and virtuous people." After one hundred and

seventy-five years of increasing specialization, a meeting of the Academy still brings together scholars in such diverse fields of knowledge that one inevitably returns, for the moment at least, to the breadth of interest of the eighteenth century founders. In recent years the stated meetings, as well as various special conferences and symposia, have been planned with the hope of appealing to a wider group than the speakers' fellow specialists. Although some meetings have been more successful than others, there is always the pleasant possibility of taking food and drink with first-rate and agreeable people that would not otherwise cross one's path. However useful these developments may have been for those who turn up at the meetings with some regularity, the *Proceedings* of the Academy as published have conveyed rather too little of this spirit to fellows living at a distance.

This problem was considered at length during the spring of 1954 by the Publications Committee, consisting of Harlow Shapley, Hudson Hoagland, Thomas J. Wilson and Waldo G. Leland, as well as a special committee under the chairmanship of Howard Mumford Jones that included Philipp G. Frank, David McCord, Rudolph Ruzicka and the present Editor. There was general agreement that, in view of the many journals of specific disciplines where the results of specialized research would normally be published, it was desirable to restrict the relatively limited space available in the *Proceedings* to articles of broader interest that might conceivably prove attractive to fellows in various classes, and to general readers outside the Academy. As a title, *Proceedings of the American Academy of Arts and Sciences* is mouth-filling rather than convenient. Moreover it does not lend itself easily to a new, typographical design which was generally desired. Something on the order of *Isis* or *Speculum*, which can easily be remembered and cited, with the traditional *Proceedings* as a subtitle, was wanted, yet the right name proved elusive until Harlow Shapley last October suddenly came up with *Dædalus*, which combines artistic and scientific implications in a manner that is elaborated by David McCord later in this issue.

In its experimental stages *Dædalus* will appear at irregular intervals, as funds and contributions permit, with not less than two numbers in each calendar year. For the benefit of harassed librarians and others who cope with serial publications it is numbered as volume 86 of the *Proceedings*, volume 84 being reserved for the continuation of Professor Bridgman's studies of high pressures, and volume 85 for a historical commemoration of the Academy's one hundred and seventy-

fifth anniversary, including a complete list of fellows from 1780 to 1955. Eventually, if *Dædalus* serves a useful purpose, we hope that regular quarterly publication may become possible, but the editing of such a journal is more than present Academy funds or the time of a volunteer editor with other things to do will permit. Rather than seek support to build up a new bureaucracy for an untried idea, it seems preferable to test the plan experimentally within the limits of available time and money and let the future take care of itself.

While *Dædalus* does not aim at popularization, it is hoped that its contents will prove of interest to fellows of all classes in the Academy. Learned writing need be only as dull, portentous or unintelligible as its authors choose. Sir Mortimer Wheeler in his recent *Archaeology from the Earth* tellingly observes: "It is not difficult to be a specialist, to write fairly intelligibly for two or three fellow-specialists, to produce 'a preparation of opium distilled by a minority for a minority.' . . . And as specialists we tend to develop a sort of professional jargon which is a deterrent to a wider audience and ultimately a handicap to the specialist himself. . . . The danger of all this jargon, at any rate in science, is not merely that it alienates the ordinary educated man but that it is a boomerang liable to fly back and knock the sense out of its users. In the words of the infallible Quiller-Couch, 'If your language is Jargon, your intellect, if not your whole character, will almost certainly correspond. Where your mind should go straight, it will dodge: the difficulties it should approach with a fair front and grip with a firm hand it will seek to evade or circumvent.'" In a 1953 Founder's Day address at the Huntington Library on a similar theme I called attention to the way in which three very different men at the peak of their professions — Sir Richard Livingstone, a classical scholar sometime Vice Chancellor of Oxford University, James Bryant Conant, a chemist now President Emeritus of Harvard University and United States High Commissioner to Germany, and Fleet Admiral Ernest J. King, our wartime Commander in Chief, United States Fleet, and Chief of Naval Operations — are "all able to express their varied thoughts in form that Geoffrey Chaucer would think well of." On the same basis, Professor James Franck's Rumford Prize address, delivered at the 9 March 1955 meeting of the Academy, indicates that when a man's work warrants this award he is quite able to convey his meaning without ambiguity.

WALTER MUIR WHITEHILL  
EDITOR

# Dædalus

DAVID McCORD

*That is the glory of Greece, that we are reminded  
of her only when in our best estate.*

—THOREAU

"PEOPLE are friends in spots," said Santayana, anticipating our contractual friendship with Dædalus, whose name is nummular and suggests an old Greek coin. Now the character of Dædalus, being somewhat spotty to begin with, clarifies and even strengthens the philosopher's words. In an age of extrinsic flight, more dwellers in this western world are acquainted with Icarus the son, whose ultimate but yet untimely fall remains (second to that of Phaëthon) the most dramatic in the realm of all mythology. Icarus is a winged name itself, and the Icarian Sea is pure poetry to eye and mind: *Icarus Icaris nomina fecit aquis*, as Ovid says.

But it is from Dædalus the father that we have borrowed the title for the new journal of our Academy. We have borrowed it for the simple reason that Dædalus enjoyed the composite reputation of being a scientist, a craftsman, a poser as well as a solver of riddles; and an individual, for all his human faults, who was likewise an architect, a sculptor, a naturalist, a metal worker, coiner of money, inventor of the ax, plummet, auger, and glue; a man of spirit, and something more than a dreamer in that he proved himself one of the best and most practical of escapists. It is regrettable that once, in a fit of jealousy, he seized the opportunity to push from a high tower his young nephew Talus, a precocious lad who invented the saw in imitation of the spine of a fish; also the first pair of compasses, and possibly other tools. It seems unlikely that we shall verify the statement that he gave us the first folding chair.

An artificer of Athens, Dædalus had also the Spartan awareness of reality. One had to be a realist to resolve not only the conception of the labyrinth but also, when the emergency presented itself, to invent a way to get out of it. Indeed, he seems at all times — or nearly all — to have qualified for Thoreauvian approval: "If you do one thing well, what else are you good for meanwhile?" On the practical side, according to Tooke's *Pantheon*—that precious volume so dear to the heart of Keats—"he also first contrived masts [Bulfinch says he was

the inventor of sails] and yards for ships; besides, he carved statues so admirably that they not only seemed alive, but would never stand still in one place; nay, would fly away unless they were chained." Even members in Class IV will appreciate the deduction that if one can fashion statues which fly away unless they are chained, it requires but a small increment of knowledge for the maker to equip himself with wings. At the same time, the exclusive quality of such genius is attested by Horace, as many will remember, in his Ode to Virgil setting out for Greece (I. iii. 34):

expertus vacuum Dædalus aëra  
pinnis non homini datis;

"Dædalus essayed the empty air on wings denied to man."

It is a well known and documented fact that Dædalus made good his escape from the Crete of Minos to the Sicily of Cocalus, but that his son, flying in poor formation, was the victim of mechanical failure. It is not for us, you may suggest, to question how a few hundred feet of altitude, with a corresponding drop in temperature, melted the wax as Icarus rose above his designated ceiling. And yet we do question it, mindful even so of that pleasant footnote-admonition in Gibbon: "Mr. Pope, without perceiving it, has improved the theology of Homer." We know, for example, that Dædalus later fashioned and dedicated to the goddess Aphrodite "a golden honeycomb so artfully wrought that it looked as though the bees themselves had modelled the six-sided cells." It is possible to assume, therefore, that the wax on the Icarian feathers was the purest of *beeswax*, with a melting point of  $100^{\circ} \pm$  centigrade. We have no way of checking what was in the Dædalic mind; but a man whose name is now formally given to the publication of a learned Society must inevitably have concluded that it was *not* the sun's rays which did the melting. He knew well enough what it was: nothing less (nothing more) than

The life of muscles rocking soft  
And smooth and moist in vernal heat.

These are the words of Robert Frost. It sometimes requires a poet to defend a scientist.

Even before Dædalus himself, the name in Greek stood for the "personification of the mysterious inventive and technical skill which created works of architecture and plastic art." It may still stand for the mysterious inventive and technical skill behind our dodecahedron

coal bunkers, textured towers, and elipticone lighting. The botanists among us know that *Dædalea* is a genus of tough pore fungi. To give the handle of this lofty Athenian to nothing better than a toadstool was a lowdown trick, if ever there was one. We are elevating the name in accord with the measure of levitation implicit in the owner. And if one should wonder about the dædal hand at work on this brief page, let him remember that *logodædaly*, one of the loveliest and most poetic of nouns, means simply "to play with words." So all of us play with words. And if we did not, there would scarcely exist an Academy such as ours, and there would be no *Dædalus* to prove it.

# Catalogue of H(II) Regions in the Milky Way

For Longitudes  $250^{\circ}$  -  $355^{\circ}$

BART J. BOK, MICHEL J. BESTER and CAMPBELL M. WADE  
*Harvard Observatory and Boyden Station, July 12, 1954*

## I. INTRODUCTION

Following the presentation of research on spiral structure by Morgan, Sharpless, and Osterbrock<sup>1</sup>, and partly at the suggestion of Dr. F. L. Whipple, a program of photography of the Southern Milky Way in H $\alpha$  light was undertaken at the Boyden Station of the Harvard Observatory. The work has been completed for the section of the Milky Way between galactic longitudes  $l = 250^{\circ}$  and  $l = 355^{\circ}$ . The present survey has been restricted to a belt between galactic latitudes  $+10^{\circ}$  and  $-10^{\circ}$ . The lower limit of apparent diameter for recognizing the nebulae is about  $4'$  because of the small scale of the camera employed in the survey.

## II. INSTRUMENTATION

The lens used is a 3-inch  $f/1.5$  Zeiss Sonnar, kindly loaned to the Harvard Observatory by Mr. Richard S. Perkin of the Perkin-Elmer Corporation. The plate scale is  $1800''/\text{mm}$ . The usable area of the sky covered by any single photograph is approximately 500 square degrees.  $4 \times 5$  inch plates are used, upon which an area 3 inches square is exposed. Aberrations and vignetting become serious near the edge of the field. This lens has proven to be quite well suited to the photography of faint, extended nebulae.

The H $\alpha$  photographs were made through a Baird multilayer interference filter with a  $50\text{\AA}$  passband centered near H $\alpha$ . The transmission at H $\alpha$  is about 70%. This filter drastically reduces the star and sky background without seriously weakening the nebulae. Since the filter must be used in parallel or near-parallel light, it is mounted in front of the objective. This reduces the effective speed of the

<sup>1</sup> A. J. 57, 3, 1952.

instrument to about  $f/2.0$  because the filter is only 2 inches square, but the advantages of narrow-band photography far outweigh the 33% loss of speed. The interference filter has a passband in the blue region which must of course be excluded; hence a Corning 2403 red glass filter is mounted directly in front of the plate.

In order to be able to distinguish between emission and reflection nebulae, and to distinguish faint extended emission from the stellar background, we made photographs in red light *excluding*  $H\alpha$  with the same instrument. For this purpose we employed another Baird interference filter, with a 50Å passband centered at 6480Å, 83Å from  $H\alpha$ . We chose this wavelength for the comparison plates because it is sufficiently far from any emission lines likely to be encountered in bright nebulae, and does not include any prominent night sky emission lines. A Corning 2404 red glass filter replaces the Corning 2403 filter. With this filter combination we obtain comparison plates that are very similar to the  $H\alpha$  plates except that the nebular light is excluded.

Throughout the present program, Eastman 103aE plates have been used. On moonless nights at Boyden Station it is possible to make exposures with the interference filter of four to six hours without appreciable fogging. The maximum exposure time is determined by the speed of the particular 103aE emulsion.

### III. METHOD OF REDUCTION

The plates were first examined under a binocular microscope and the nebulous images were marked. A suspected nebula was accepted as real only after it had been identified on at least two  $H\alpha$  plates. The position of each nebula was then examined on a comparison plate; if no nebula was seen, or if it was very much fainter than on the  $H\alpha$  plate, the object was accepted as a hydrogen emission region.

The boundary of each nebula was sketched as accurately as possible on Henry Draper Extension charts<sup>2</sup> or on large-scale chart plates. The geometrical center of the boundary thus drawn was defined as the position of the object and the coordinates for the epoch 1900 were determined. The east-west and north-south diameters of the object were measured directly from the sketch. At this time the immediate vicinity of the nebula was examined for early-type stars with which it might be associated.

<sup>2</sup> Harvard Annals 112, 1949.

The  $H_{\alpha}$  and comparison plates were enlarged and printed on high-contrast paper in order to facilitate the search for very faint extended regions which could not be detected by the method outlined above. Great care was taken to make the stellar images similar on corresponding  $H_{\alpha}$  and comparison prints.

#### IV. DESIGNATION AND CLASSIFICATION

Each nebula observed is given a number based upon the galactic coordinates of its center. The first three digits of the assigned number are the whole-number part of the galactic longitude of the object. The last two digits are the whole-number part of the galactic latitude. If the latitude is negative the last two digits are italicized. Thus IC 4701,  $l = 341.^{\circ}9$ ,  $b = -1.^{\circ}6$ , is designated 34101. In case more than one object should receive the same number, the one with the lowest galactic longitude has its number followed by the letter *a*, the one with the next lowest longitude is followed by the letter *b*, etc. For example, in the catalogue we have 31800*a* and 31800*b*. This system of numbering was adopted for the following reasons: (a) the number gives the approximate location of the object and (b) other objects can later be added to the catalogue usually without disrupting either the continuity of the numbering system or the arrangement of the catalogue.

The adopted classification system was designed to give a concise qualitative description of the nebulae observed. The classification criteria are structure, or shape, and surface brightness. The apparent and linear sizes of the nebulae do not enter into the classification. The types and their criteria are as follows:

Type I: Irregular nebula with very high surface brightness. Always associated with dark nebulosity. A typical object of this class is 34202 (M17).

Type II: Irregular nebula with very low to moderate surface brightness. This type sometimes shows marked filamentary structure. Usually no associated dark nebulosity is discernible on the small-scale  $H_{\alpha}$  plates. An example is 34600 (NGC 6604).

Type III: Apparently spherical H(II) region, with the exciting star located at the geometrical center. A typical example is 32301.

Type IV: Incomplete ring. 29400*a* is typical of this class.

Type I-II: Type I mixed with, or surrounded by, Type II. An example is 33402 (Region containing M8 and M20).

In any case where a nebula displays characteristics of two classes, it is given a composite classification; e.g., 31100 is classified as I-IV.

TABLE I  
CATALOGUE OF NEBULAE

Number	1900	1900	Type	Dimensions	References
25500	10 <sup>b</sup> 41. <sup>m</sup> <sub>2</sub>	-59° 13'	I-II	450' X 330'	A
26201	11 30.2	-62 22	I-II	108 104	A
27300	13 13.0	-61 56	III?	9 11	
27500	13 25.8	-61 46	II	45 54	
27600	13 33.0	-61 14	II	17 5	
27700	13 40.3	-62 7	II	19 20	
27901	14 2.5	-61 25	II	61 83	
28100	14 12.5	-60 48	II	22 26	
28801	15 8.5	-57 50	II	12 9	
28802	15 7.8	-58 58	II	39 51	
28900	15 11.7	-56 19	II	8 7	
29400a	15 34.0	-53 49	IV	20 15	
29400b	15 37.7	-53 55	II	15 15	
29400c	15 36.7	-53 36	II?	5 5	
29400d	15 39.8	-53 42	II	9 14	
29401	15 44.5	-54 19	II?	14 11	
29501	15 47.7	-54 21	I?	11 14	
29902	16 12.5	-51 32	II	140 108	
30000	16 3.1	-48 47	II	42 32	
30000	16 5.3	-49 55	II	15 8	
30402	16 30.8	-48 24	I-II	204 149	A
31100	16 45.2	-41 4	I-IV	224 301	A, D
31500	16 57.2	-37 42	III	147 147	A, D
31800a	17 10.5	-36 15	II	17 6	
31800b	17 12.5	-35 44	I-II	42 49	A, D
32100	17 18.4	-34 3	I-II	63 43	A, B, D
32300	17 22.7	-31 27	III	43 42	B, D
32301	17 28.1	-32 31	III	116 121	A, B, D
32603	17 42.8	-31 13	IV	24 24	D
32701	17 41.4	-29 5	II	13 13	B, D
32801	17 40.6	-29 15	II	19 15	D
33201	17 48.3	-24 54	II	89 90	B, C, D
33402	17 59.6	-23 48	I-II	135 108	A, B, C, D
33903	18 11.6	-19 43	II	13 13	A, B, C, D
34101	18 10.7	-16 43	II	42 60	A, B, C, D
34201	18 0.3	-14 12	IV	14 14	B, C, D
34202	18 15.0	-16 13	I	55 54	A, C, D
34400	18 13.2	-13 49	I-II	71 58	A, B, C, D
34401	18 16.8	-14 36	II	4 4	C, D
34600	18 13.6	-12 13	II	81 84	B, C, D
35201	18 31.1	-6 47	II	12 11	C, D

## V. THE CATALOGUE

The observed nebulae are listed in Table I. Paragraphs relating to individual nebulae follow the table. Bright condensations of emission regions are not listed individually; each field of connected nebulosity received one overall designation. For example, M8 and M20 are not listed separately since they are observed to be connected by faint emission. They are instead regarded as bright Type I condensations in a field of Type II nebulosity.

The arrangement of the catalogue is as follows:

Column 1: The designation in the system described in Section IV.

Columns 2 and 3: Right ascension and declination for the epoch 1900.

Column 4: Type according to the system outlined in Section IV.

Column 5: Angular dimensions in minutes of arc, east-west versus north-south.

Column 6: References to previous lists published by other workers, as follows:

A. S. Cederblad, *Lund Medd.*, Sr. II, No. 119, 1946.

B. G. Courtes, *Comptes Rendus* 252, 795, 1951.

C. V. F. Hase and G. A. Shajn, *Bulletin of the Crimean Astrophysical Observatory* IX, 52, 1952.

D. S. Sharpless, *Ap.J.* 118, 362, 1953.

## REMARKS ON THE INDIVIDUAL NEBULAE:

- 25500  $\eta$  Carinae Nebula and associated nebulae. This region and 26201 have been the subject of a recent detailed study by Dr. Dorrit Hoffleit<sup>3</sup>. For details we refer to Dr. Hoffleit's paper.
- 26201 Possibly associated with 25500. The main body of the nebula is IC 2944, with important condensations at IC 2872 and around  $-61^{\circ}2350$  and  $-63^{\circ}1904$ .
- 27300 Bright.
- 27500 Considerable associated dark nebulosity.
- 27600 Very faint.
- 27700 Possibly associated with the galactic cluster NGC 5281.
- 27901 Very faint.
- 29400b Very faint.
- 29400c Very faint.
- 29400d Very faint.

<sup>3</sup> *Harvard Annals* 119, No. 2, 1952.

- 29902 Large field of faint nebulosity. There are a number of irregular brighter patches scattered through the nebulosity.
- 30000 Very faint.
- 30402 Includes NGC 6164, NGC 6165, NGC 6188, and NGC 6193 (galactic cluster).
- 31100 Consists of a nearly complete ring centered on the OB association NGC 6231. The ring is faint except at the northern extremity where it is very bright. The bright portion is IC 4628. There is no detectable nebulosity within the loop. The southern portion of the loop includes McDonald 68.
- 31500 McDonald 70. At the center of the nebula is the galactic cluster NGC 6281. The appearance of this object is much mutilated by overlying dark nebulosity.
- 31800a Three small, faint condensations in a row. Possibly connected with the faint westward extension of 31800b.
- 31800b Five small bright condensations, of which the south following is NGC 6334. On the north following side is a somewhat fainter large patch of nebulosity. There is a very faint and ill-defined arm extending about two degrees to the westward.
- 32100 NGC 6357. Highly filamentary structure.
- 32301 McDonald 69. The galactic cluster NGC 6383 is at the center of this object.
- 32603 Very faint.
- 32801 Very faint.
- 33201 S 181.
- 33402 A large complex of connected nebulosity containing Messier 8 and Messier 20. There is considerable associated dark material.
- 33903 IC 1284.
- 34101 IC 4701.
- 34201 S 185.
- 34202 Messier 17 and the associated nebulae IC 4706 and 4707. There is much dark material involved.
- 34400 Messier 16.
- 34401 S 194.
- 34600 NGC 6604.
- 35201 S 198.

## VI. EXTENDED BACKGROUND EMISSION

Between galactic longitudes  $250^\circ$  and  $277^\circ$  is a large field of faint emission upon which the brighter nebulae are superposed. Between longitudes  $303^\circ$  and  $317^\circ$  is another such faint extended field. Their limits are not very well defined. Any attempt at tabular cataloguing of such emission fields seems to be pointless; hence their boundaries are only indicated by dotted lines in the accompanying charts.

## VII. EXCITING STARS

In Table II are listed the stars which may be contributing to the excitation of the nebulae in Table I. No stars are listed for 25500 (the  $\eta$  Carinae Emission Complex), because it is situated in a large field of early-type stars and it would be unwise to suggest on the basis of our material which are actually associated with the nebula. Only stars of spectral type B<sub>3</sub> or earlier are listed in Table II. Numbers lower than 200,000 refer to the Henry Draper Catalogue; those higher than 300,000 refer to the Henry Draper Extension<sup>2</sup>. There are also four stars from the Bonner and Cordoba Durchmusterungs.

TABLE II  
EXCITING STARS

Nebula	Star	Nebula	Star	Nebula	Star	Nebula	Star
26201	99953	27300	115316	29501	142152	30402	148937
	100099		115455		142237		148989
	100199						149019
	100444	27500	117297	29902	145492		149076
	100495		117357		145664		149298
	101008		117492		145794		149426
	101131		117513		145828		149855
	101190		117688		145846		150135
	101205		117704		146919		150136
	101298		117797		147049		150168
	101332		118016		147318		150197
	101413				147331		150373
	101436	27700	119646		147419		150958
	101545	27901	122669		147617		151213
	101964		122691				151300
308670							330806
308762		28100	124909	30000	144900		330842
308815			125206		144918		331023
308832			125241		144969		331051
308904					144970		
308935	28802	134877				31100	150742
308937		134959		30000	145217		151003

TABLE II — *Continued*

Nebula	Star	Nebula	Star	Nebula	Star	Nebula	Star
31100	151139	31100	322294	31100	326365	33402	164816
	151212		322373		326473		164833
	151397		322396		326475		164865
	151515		322417		326522		164906
	151564		322422		326525		164971
	151804		322431		326533		165016
	151932		322433		326635		165052
	152003		322447		326250		165132
	152042		322452				165921
	152060		325905	31500	153919		166033
	152076		325916		153426		166056
	152147		326006		154040		314853
	152199		326009				315033
	152217		326033	31800b	319699		315035
	152218		326040		319702		
	152219		326051		319703	33903	167722
	152233		326089				167815
	152234		326099	32100	157504		
	152235		326137			34101	167397
	152236		326138	32300	158186		167633
	152246		326155		317707		167657
	152247		326165				167791
	152248		326167	32301	-33°12155		
	152249		326176		158860	34201	165319
	152270		326209		159176		
	152291		326286		159455	34202	168163
	152314		326293		317757		168607
	152333		326296		317819		168625
	152405		326297		317888		
	152407		326305			34400	168075
	152408		326306	32603	161853		168076
	152424		326310		318406		168137
	152435		326317				168183
	152623		326326	32701	316311		168504
	152667		326327		316326		
	152723		326328			34401	168894
	152742		326329	33201	162717		
	152756		326330		162718	34600	-11°4586
	153295		326336		162978		-12°4970
	153677		326339				-12°4982
	322089		326343	33402	164402		167971
	322138		326347		164492		168112
	322211		326348		164536		168206
	322276		326351		164637		
	322282		326364		164794		

PHOTOGRAPHIC ATLAS  
OF THE SOUTHERN MILKY WAY  
IN  $H\alpha$  LIGHT

$l=250^\circ$  to  $l=355^\circ$

\*

The photographs that follow were taken at the Boyden Station of the Harvard Observatory, either by M. J. Bester or under his immediate supervision. For Figures I through VII the scale is  $56'/\text{cm}$ .

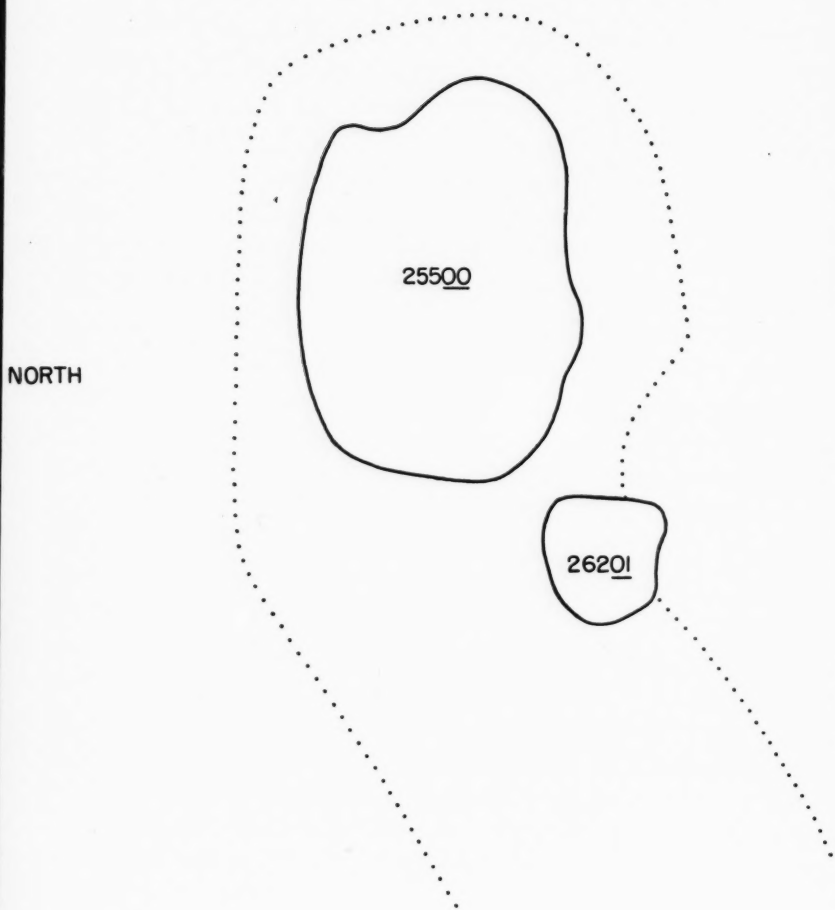
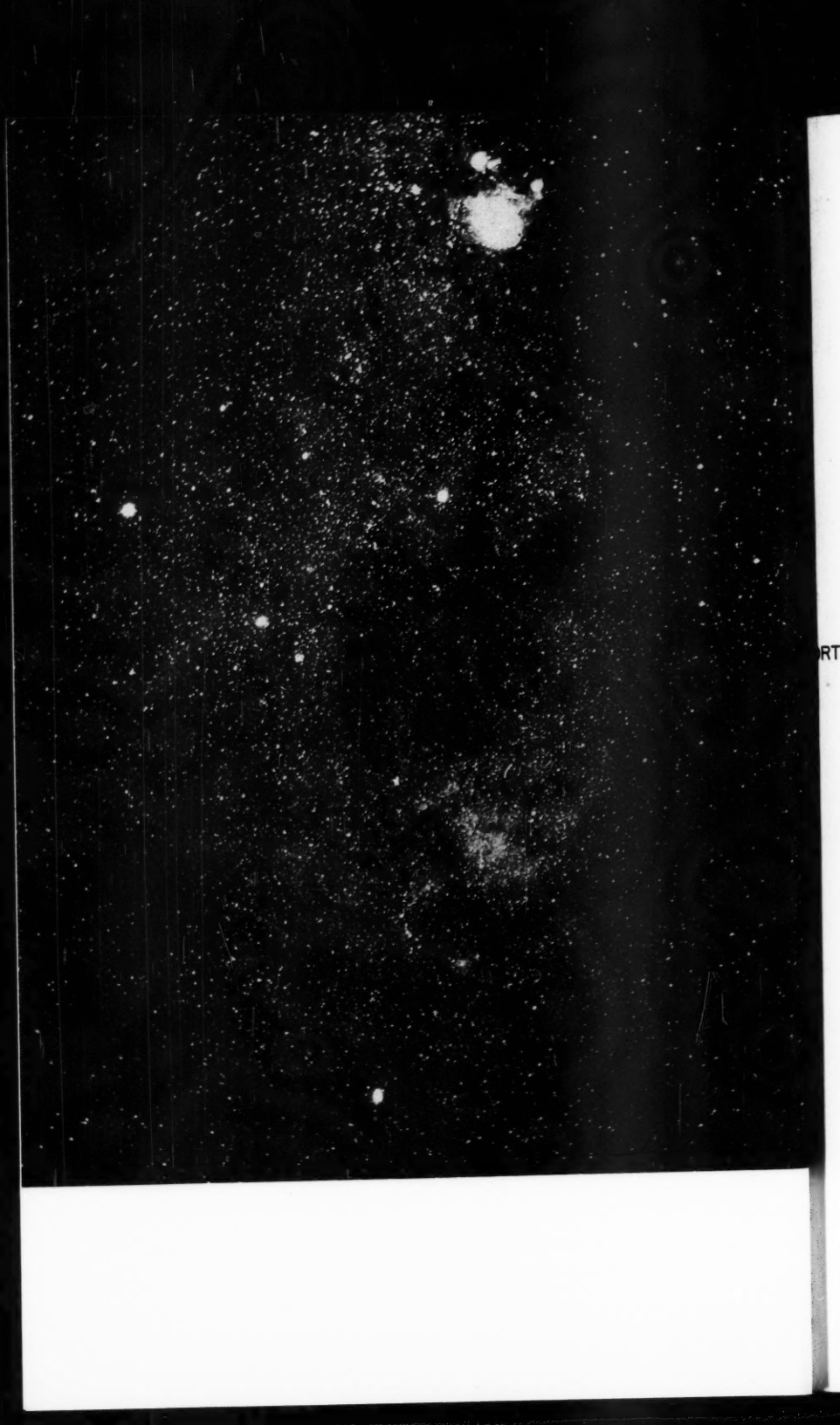


PLATE I  $\eta$  Carinae region in  $H\alpha$  light. Dotted lines indicate approximate boundaries of faint extended emission.





RT

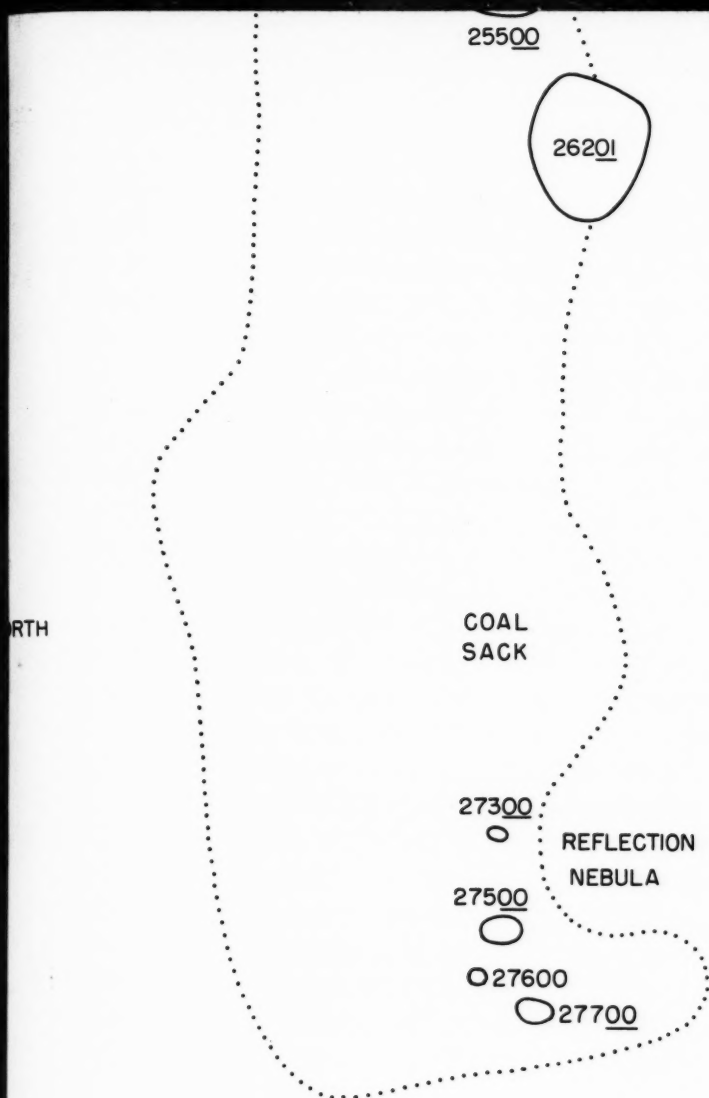


PLATE II Coal Sack region in  $H\alpha$  light. Dotted lines indicate approximate boundaries of faint extended emission.

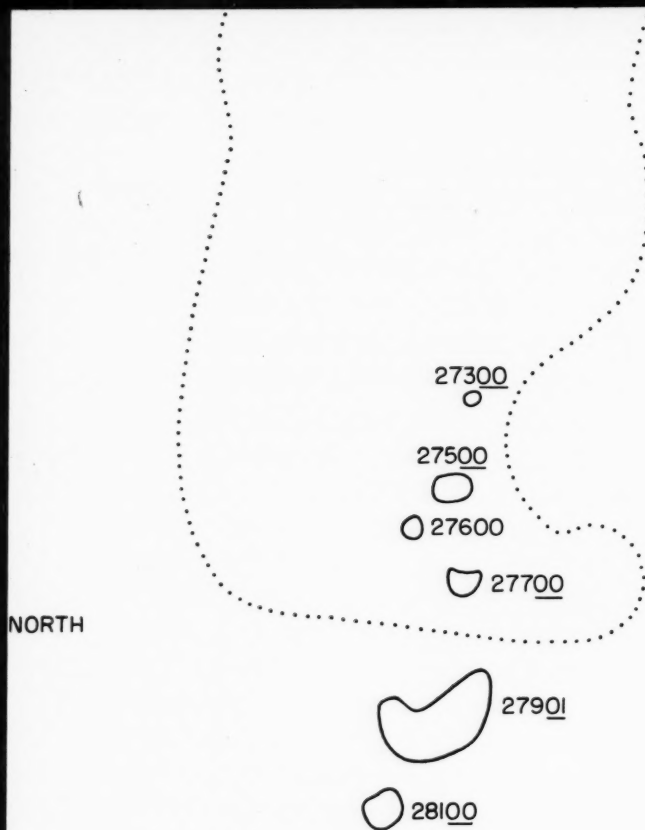
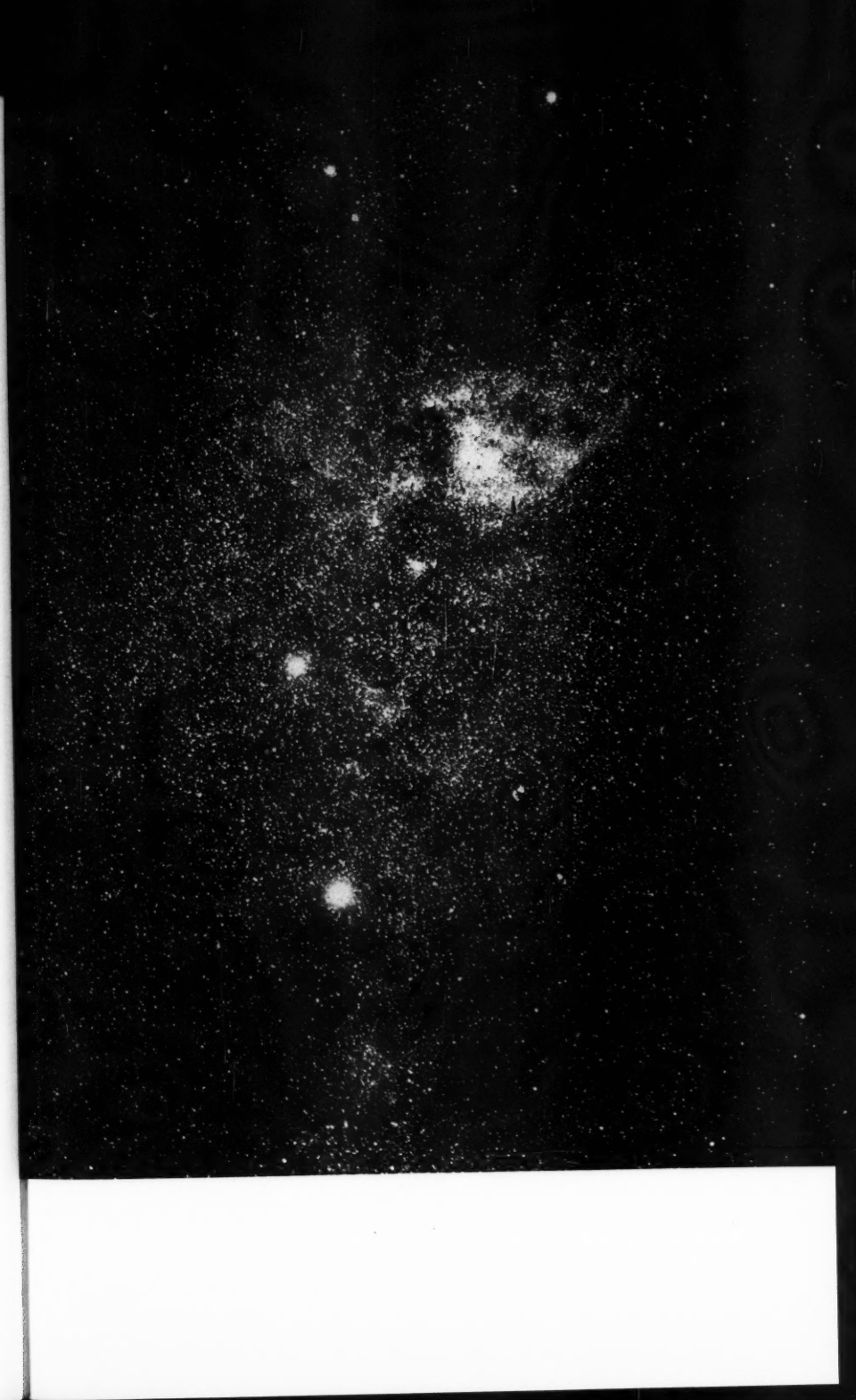
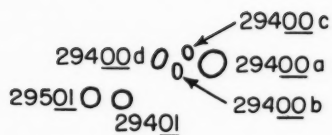


PLATE III Milky Way in Centaurus in  $H\alpha$  light. Dotted lines indicate approximate boundaries of faint extended emission.





NORTH



○ 28900

○ 28801

○ 28802

PLATE IV Milky Way in Ara, Norma, and Circinus in  $H\alpha$  light.

NORTH

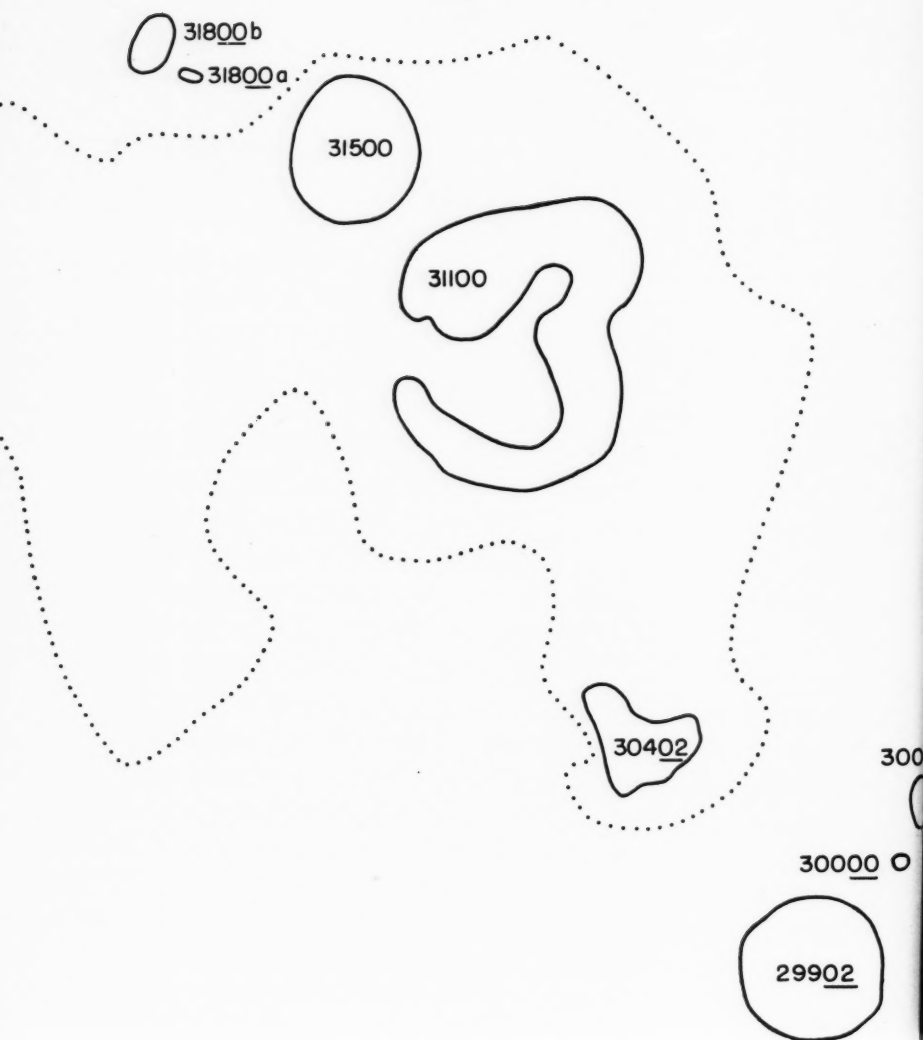
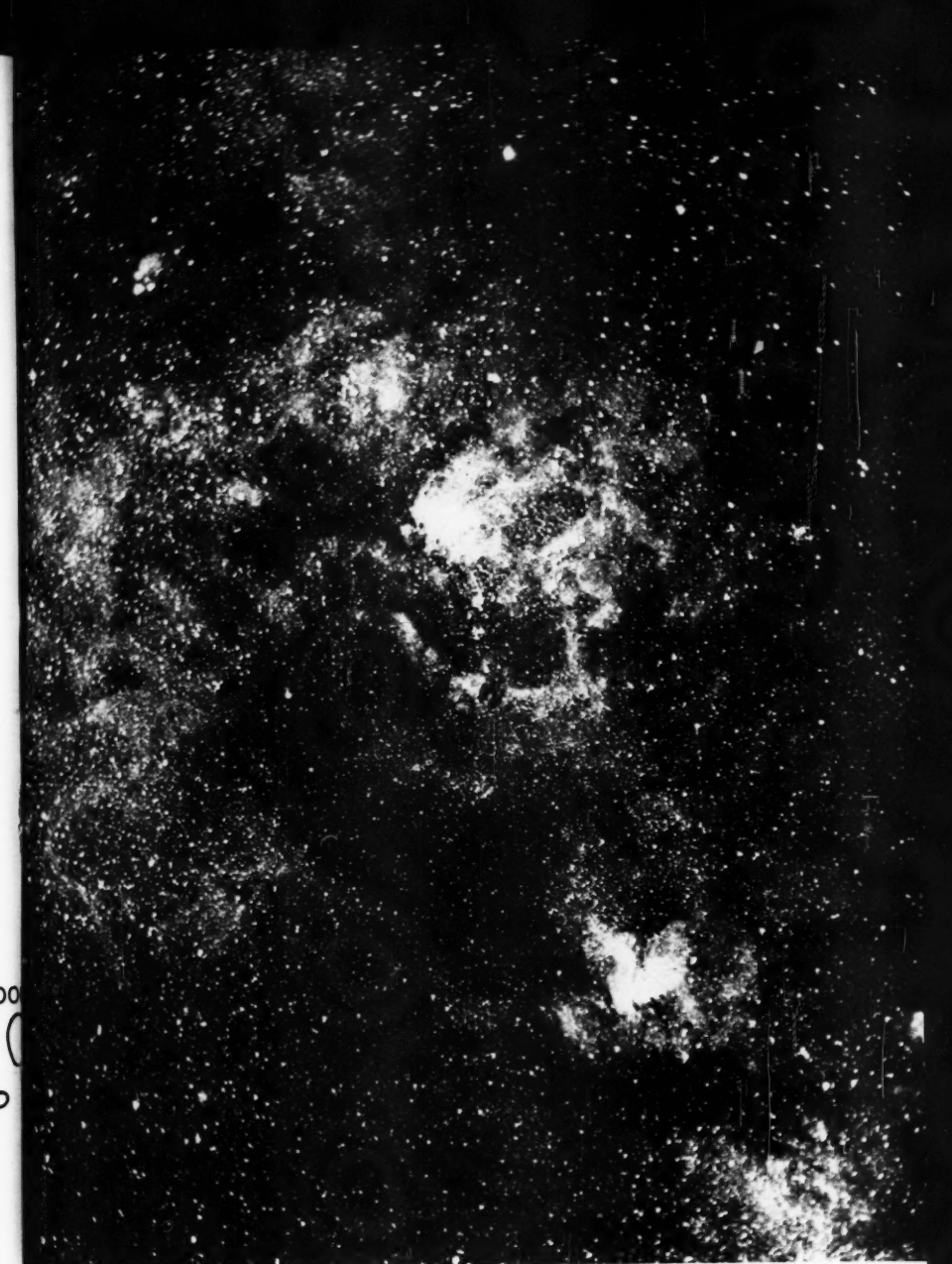


PLATE V<sub>2</sub> Milky Way in Scorpius in H $\alpha$  light. Dotted lines indicate approximate boundaries of faint extended emission.

00  
(  
D





NORTH

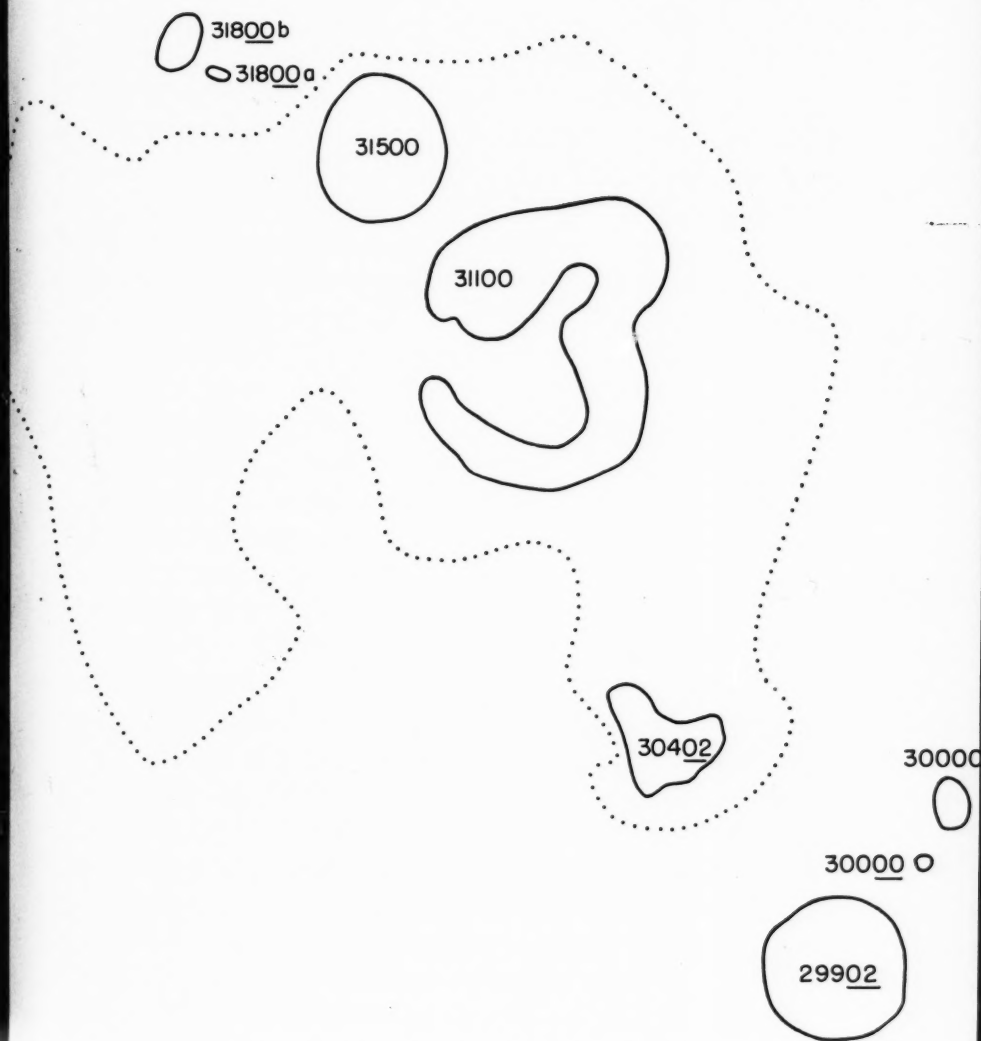


PLATE Vb Same region as shown in Plate Va. Effective wave-length: 6480A. This is a comparison plate, excluding H $\alpha$  light.

NORTH

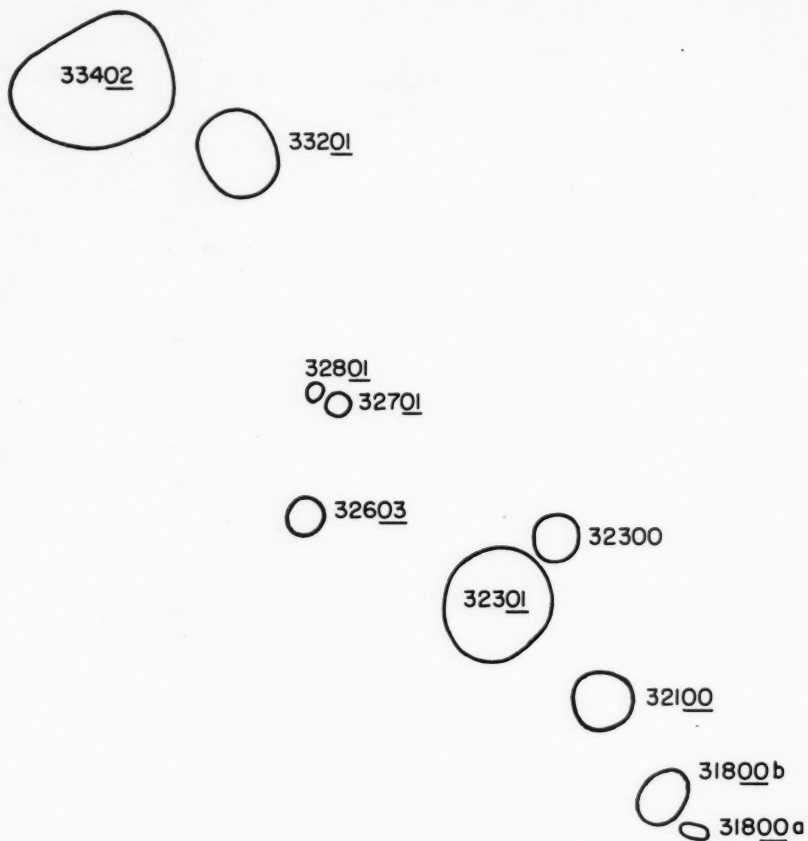


PLATE VIa Milky Way in Sagittarius.  $H\alpha$  light.





NORTH

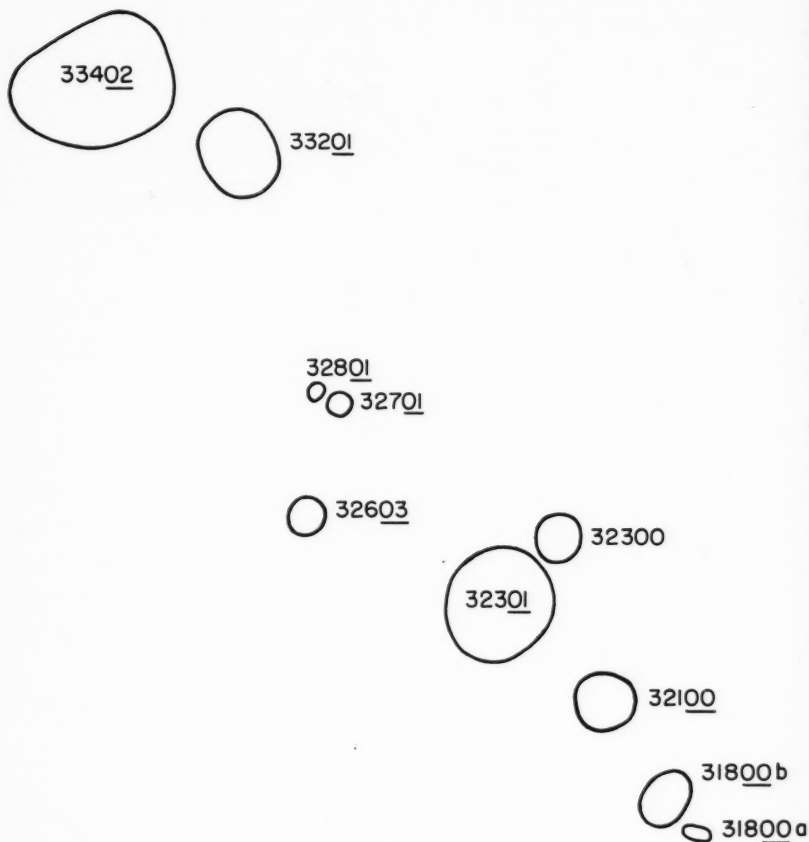


PLATE VIb Same region as shown in Plate VIa. Effective wave-length: 6480Å. This is a comparison plate, excluding H $\alpha$  light.

NORTH

○ 35201

○ 34600

○ 34400

○ 34401

○ 34201

○ 34202

○ 34101

○ 33903

PLATE VII Milky Way in Sagittarius and Scutum in H $\alpha$  light.

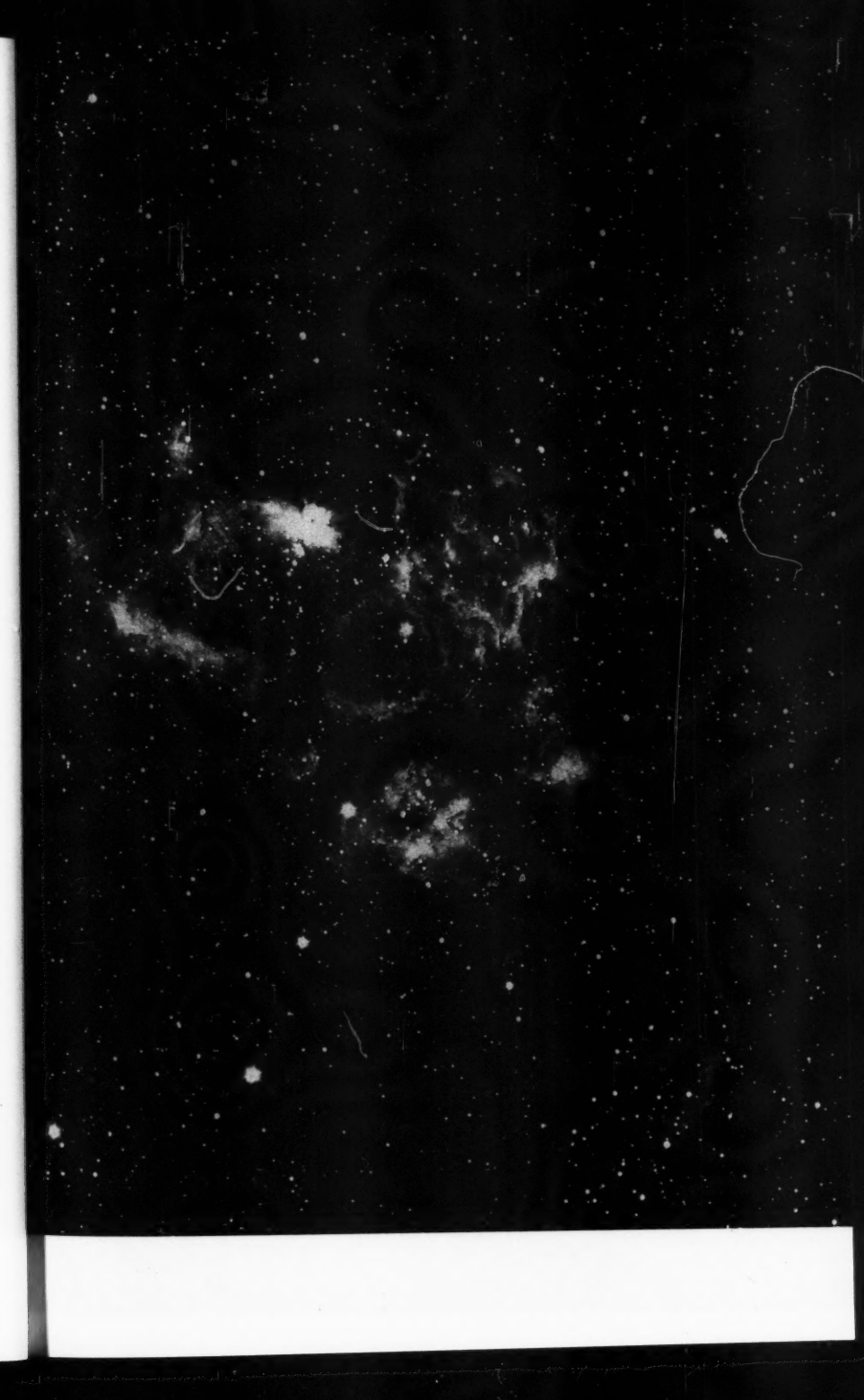
O  
42





PLATE VIII No. 31800b. Plate taken with the 32-36 inch Baker-Schmidt telescope at the Boyden Station of the Harvard Observatory. 90-minute exposure in red light, taken by M. J. Bester. North is in the direction of the upper right-hand corner; east is toward the lower right. The lower right condensation of nebulosity is NGC 6334. Scale: 2.'8/cm.

PLATE IX No. 32100. 90-minute exposure in red light, taken with the 32-36 inch Baker-Schmidt telescope by M. J. Bester. North is at the top of the photograph; east is at the right. The WC6 star HD 157504 is just to the right of the brightest condensation of nebulosity, which is NGC 6357. Scale: 3.5/cm.



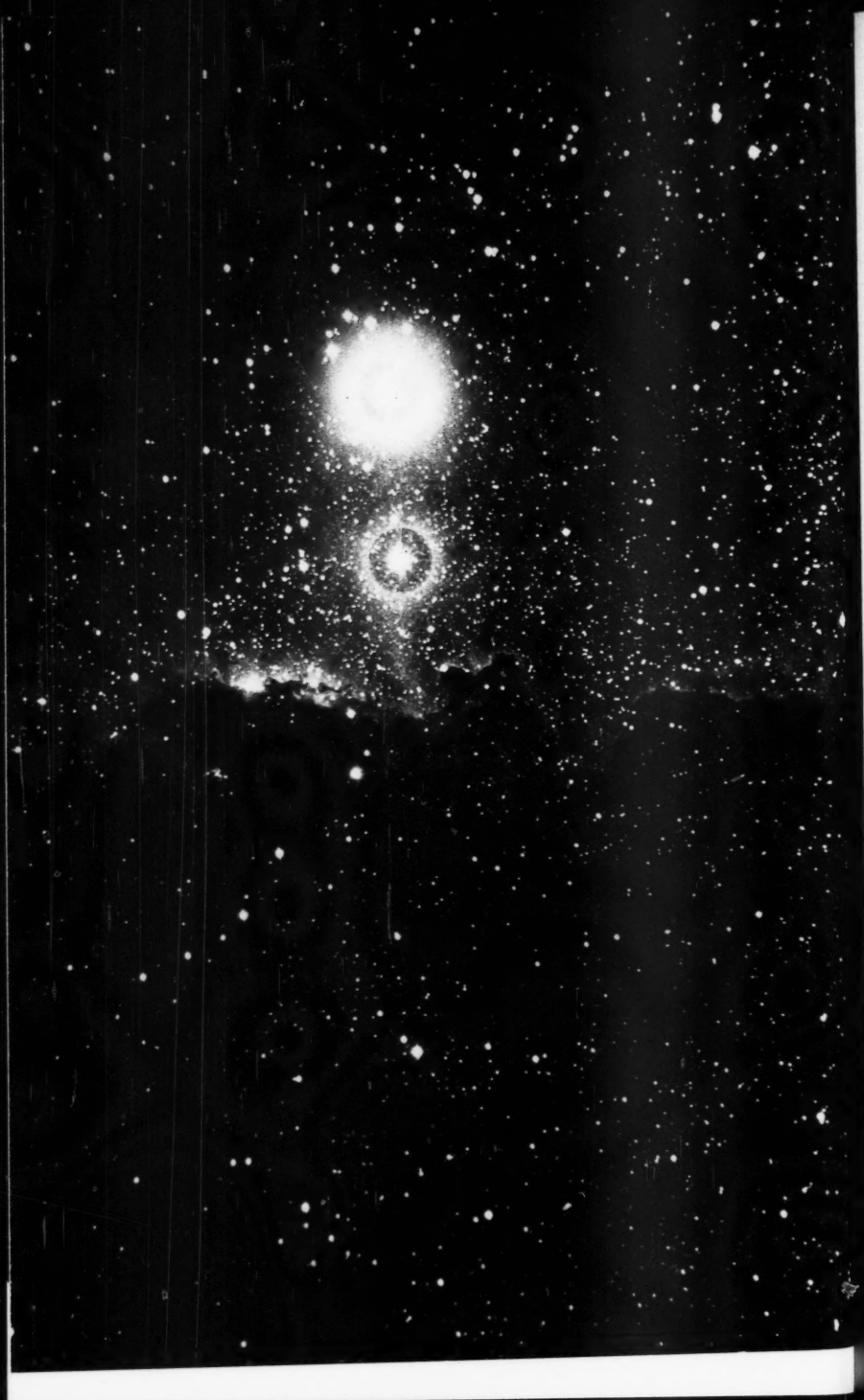
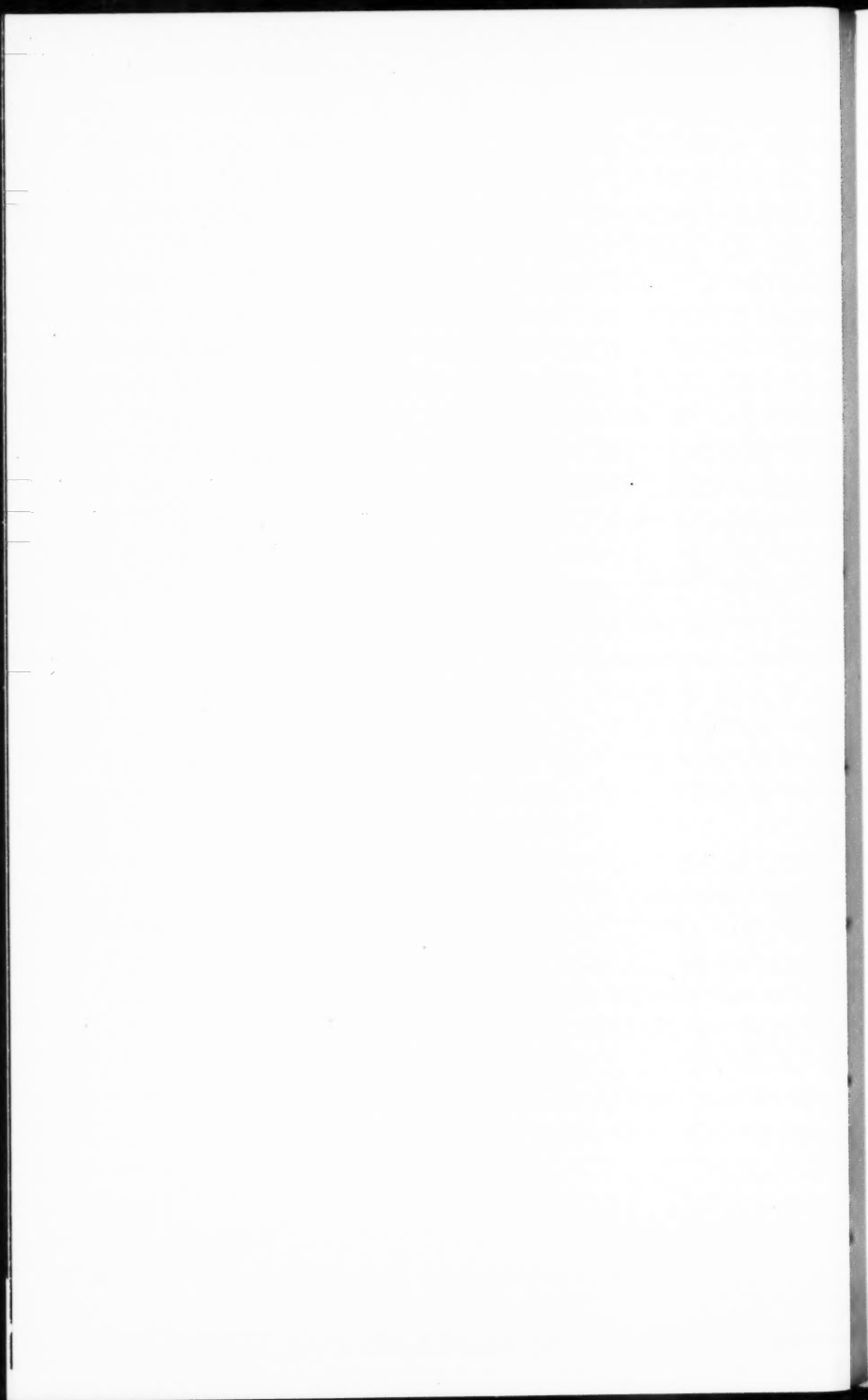


PLATE X Part of No. 30402, photographed by M. J. Bester with the 60-inch Rockefeller reflector at the Boyden Station. 60-minute exposure without filter on a red-sensitive Eastman 103a-E plate. North is at the right; east is at the top. The bright star in the upper middle part of the photograph is the double O-star, HD 150135-6. Scale: 2.'2/cm.



*Rumford Medal Lecture 1955*

# Physical Problems of Photosynthesis

JAMES FRANCK

TWENTY-EIGHT years ago, the American Academy of Arts and Sciences elected me to honorary membership. Today, for my work on photosynthesis, she bestows upon me her greatest distinction — the Rumford medal. I am deeply grateful to the members of the Academy and happy about the confidence they have shown in my work. I accept this great honor. I hope the good judgment hitherto shown by the Academy in the choice of recipients of the Rumford medal has not failed her entirely in my own case.

There is no doubt that the approach to the problems of photosynthesis by the means and methods of physics is sound. Their application has given us much needed information supplementing that gained by chemists, biochemists and plant physiologists. However, only the future can show whether the general interpretation of the results gained with the tools of physics and physical chemistry is correct. The history of research on photosynthesis has recorded far too many instances when the acceptance of a solution to a particular problem was followed by the disillusioning recognition of error.

I had originally intended to survey for you the status of all phases of photosynthesis. To make this understandable to the scholars in the many diverse disciplines represented here tonight, to do this adequately within a reasonable length of time — in order not to try your patience unduly — was to me an obstacle which I could not overcome. I must, therefore, restrict myself and discuss only the physical aspects of photosynthesis. The very impressive contributions of biologists, chemists and others will be mentioned only in so far as is necessary for developing our main topic.

Photosynthesis is the unique process in plants whereby, with the help of light, organic matter is synthesized from carbon dioxide and water. Ultimately, a living plant is the only source available on earth of the food needed for the maintenance of life and, indeed, of the compounds from which all living cells are built. In our typical green

plants, the overall reaction is the synthesis of carbohydrates. This process is coupled with the evolution of oxygen. For the reduction of carbon dioxide to the oxidation state of carbohydrate, four hydrogen atoms are needed. These are obtained from four water molecules; the residue, four hydroxyl groups, leads to the production of molecular oxygen. The overall reaction described is exactly the reverse of so-called tissue respiration, the basic process by which, in most living systems, carbohydrates are oxidized by molecular oxygen. As final products carbon dioxide and water result. This kind of slow combustion, which provides the energy for all the other

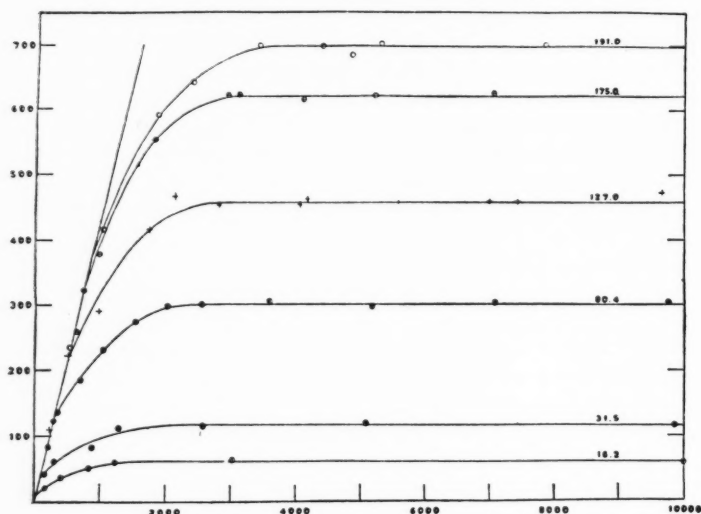


FIGURE 1. *Carbon dioxide assimilation curves.*

chemical and mechanical processes of living matter, is regulated by the action of catalysts called enzymes. Both processes, synthesis and degradation, go on simultaneously in the plants. The synthesis using sunlight as a source of energy must proceed faster than respiration in order to result in carbohydrate storage. In photosynthesis, not only photochemical reactions play a role, but also light independent reactions. These, just as the reactions of respiration, are enzymatically controlled. It suffices to note the dependence of the photosynthetic rate upon light intensity to demonstrate this point, as shown by the

set of curves in Figure 1. The ordinate represents the photosynthetic rate and the abscissa gives the corresponding light intensity. The curves show that only in the region of low intensities does the rate rise in proportion to the light intensity. If only photochemical processes were involved in photosynthesis, the rise should continue to be linear even at high intensities. The fact that in the region of high intensities the rates do not rise further with increasing light shows that, at light saturation, the rates are limited. This is because the light-independent reactions have reached their maximum rates — typical of an enzyme-controlled reaction. One cannot do better than to engage all enzyme molecules simultaneously. This explanation became a certainty when numerous experiments made quite early by many observers showed that saturation rates are diminished by all conditions which reduce the efficiency of enzymes — such as enzyme poisonings, low temperatures and substrate deficiencies. In the example of Figure 1, the lowering of the saturation rate corresponds to limitations caused by lack of carbon dioxide, i.e., a substrate limitation.

For the promotion of the photochemical processes only the visible light which penetrates the earth's atmosphere is available. This light is absorbed by the plant pigments or dyestuffs present in all photosynthesizing cells and not by the reactants — namely, carbon dioxide and water — mentioned previously. Several dyestuffs are known to utilize the light energy they absorb for the photochemical reactions of photosynthesis. In our green plants, only one of them, called chlorophyll *a*, is directly engaged in photosynthesis. The others absorb light but transfer the energy to the chlorophyll *a* by a process to be discussed later on.

The quantum theory has shown that light is absorbed and emitted in the form of discrete energy units called quanta. The energy content of a quantum is proportional to the frequency of the light. Quanta of blue light contain more energy than quanta of red light. A mole of quanta, i.e.,  $6 \times 10^{23}$  quanta, of red light having the longest wavelength of the red absorption spectrum of chlorophyll provides an amount of energy equal to 41 kcal. This energy minus inevitable energy losses is, under optimal conditions, available for photochemical purposes. This is not only true when the plants are irradiated with red light but also when light of shorter wavelengths, for instance, blue light, is chosen. The reason is that chlorophyll molecules immediately dissipate the excess of energy which the quanta of blue light have over the quanta of red light. The question arises how many quanta have

to be absorbed under optimal conditions to reduce one carbon dioxide molecule to a carbohydrate group and to evolve one oxygen molecule. Otto Warburg, more than 30 years ago, was the first to determine this number experimentally. He measured the light energy absorbed and the rate of the resulting gas exchange. He found that four quanta were needed. This appeared to be a sensible result because it seemed to indicate that each quantum which was absorbed caused the transfer of one hydrogen atom to the substance being reduced. However, other investigators could not confirm Warburg's results. They, in turn, found that their optimal quantum number was as high as eight. Warburg repeated his work with a different technique and found that, under his new conditions, three quanta, or even 2.8 quanta, were sufficient.

The basic laws of physics can be applied to photochemical reactions in general and to photosynthesis in particular. Using these laws a conservative estimate of the energy losses involved in these reactions can be made. The conclusion is that the reduction of carbon dioxide by less than four quanta is impossible. Even a quantum requirement of only four is still, in all probability, too low. Warburg's results can be explained by the assumption that, under the special conditions of his experiments, a reduction of half-oxidized respiratory intermediates is favored, rather than the reduction of carbon dioxide. Many theoretical and experimental considerations support this view. We do not have time to discuss all phases of this long-lasting and not-quite-finished controversy. But, it may be mentioned that Warburg in his latest papers has stated that he is only able to observe low quantum numbers when he resorts to very special and strange conditions. Under normal conditions he obtains the high values of other investigators. Indeed, it is just these new measurements used in calculating the lowest values which are also experimentally the most dubious, as my colleague Gaffron pointed out to me. We, therefore, come to the conclusion that in photosynthesis two quanta are normally needed for the transfer of one hydrogen atom.

I may add that chlorophyll promotes not only photosynthesis but, when dissolved in organic solvents and in the presence of oxygen, induces oxidation reactions. When chlorophyll is dissolved in the skin, irradiation can cause violent inflammation comparable to the effect of excessive exposure to ultraviolet light. In this instance we have an example of light absorption by chlorophyll which can result in damage to living matter. That this does not occur in plants under natural conditions is truly remarkable.

Chlorophyll in plants is adsorbed on a protein. It is this chlorophyll-protein complex which is directly involved in the photochemical process of photosynthesis. Yet, this complex is also able to reduce photochemically certain other substances, like quinone, which easily penetrate the cells. The reduction of quinone is accompanied by an oxygen evolution similar to that of normal photosynthesis. Many other substances which do not penetrate the cell can still be reduced with a corresponding oxygen evolution when, instead of whole cells, so-called chloroplasts are suitably isolated, suspended and irradiated. R. Hill in Cambridge, England, observed the first example of such reactions. These chloroplasts are the special entities in the cell which contain all the photosynthetic dye-protein complexes. They can easily be taken out of the cells as whole units and separated from cell debris by centrifugation. The chloroplasts can be further broken up so that only small dye-protein complexes remain intact. In both cases the capability for reduction of a great number of substances called Hill reagents, such as the quinone mentioned previously, remains. Nevertheless, in these isolated chloroplasts or chloroplast fragments little, if any, normal photosynthesis is observed.

The facts mentioned so far pose a number of problems. The methods of physics and physical chemistry can contribute to their elucidation. I mention some of these which are especially interesting: Is there a special property of the absorption spectrum and of the molecular structure of chlorophyll which gives us an indication as to why this dye is unique in the promotion of the photochemical reactions of photosynthesis? Do these offer us a plausible explanation as to how the energy of two quanta can be utilized for the transfer of one hydrogen atom? How is the high concentration of chlorophyll in the chloroplasts prevented from inducing the excessive and damaging oxidation processes which it can promote in the presence of oxygen when dissolved in organic solvents? Is this potentially damaging behavior prevented by the position of the chlorophyll molecule at the interface between protein and lipid?

Studies of the absorption spectra of chlorophyll *in vivo* and *in vitro*, measurements of its fluorescence and chemiluminescence spectrum under a variety of external conditions, application of chemical kinetics to the photochemical reactions of photosynthesis and of other photochemical processes involving chlorophyll—these are obviously means of getting some information on our problems.

Research of this type has been done for more than 20 years in a

number of different laboratories. There is no essential disagreement about the experimental results. However, no unanimity has been reached regarding the interpretation of these data. In some cases a real ambiguity exists. In others I cannot help but feel that incomplete familiarity with, and understanding of, the literature and principles of physics may account for the differences of opinion.

Before presenting results and the conclusions to which they have led I have to discuss some of the phenomena which we encounter and also the nomenclature of physics in so far as we have to use it.

I suppose everyone knows that atoms and molecules have nuclei, which contain nearly the whole mass of these particles, and a cloud of very light electrons, which move around the nuclei comparable to planets moving around central stars. Atoms have only one nucleus, molecules as many as the number of atoms in the particular molecule. Quantum theory postulates that the electronic clouds can exist only in discrete states which differ in their energy content. These states are called quantum states. At low and moderate temperatures practically all the atoms are in the lowest or ground state. Only light of such wavelengths is absorbed whose quanta have the right energy to throw the electron cloud from the ground state into one or another of the higher states, called excited states. The absorption spectrum consists therefore of discrete spectral lines. Atoms excited by light retain their excitation energy only for a short time. When excited by visible light their natural average lifetime is about a hundred millionth of a second. At low gas pressures where collisions with other particles are rare during the natural lifetime of the excited state, the loss of excitation energy occurs entirely by reemission of light, called fluorescence. The fluorescence can be quenched and the natural lifetime of the excited atoms correspondingly lowered by collisions with other particles. When the added gas consists of atoms which can be excited by longer wavelengths not present in the light used for the excitation of the first species, the original fluorescence will be replaced by the fluorescence of the added species. This process, called sensitized fluorescence, indicates that the excitation energy can be transferred from the atoms that originally absorbed the light to the electronic cloud of another atom with suitably located excitation states. Sensitized fluorescence can be very efficient. For instance, the energy can be transferred even though the atoms of the two species are not in direct contact with each other. This can occur provided that the indirectly excited species has one excitation state of energy equal, or nearly

equal, to that of the excited states of the directly excited atoms. This transfer quickly becomes much less efficient when the difference in energy between the directly and the indirectly excited states becomes greater. In this case a real mechanical collision is needed to transfer the surplus energy into relative translational energy of the colliding pair. The law of conservation of momentum is the reason why interaction of the movement of the cloud of light electrons with the movement of the heavy masses is small; the heavy particles can neither change their positions nor their velocities during the very brief time it takes for the electrons to rearrange their spatial and momenta coordinates. Quenching impacts between excited atoms and others which have only higher excitation levels than the directly excited atom, therefore, do not occur at room temperatures. At high temperatures, where the interactions between the heavy masses are correspondingly more violent, quenching becomes possible.

An impact of an excited atom with another atom, whose quantum states lie too high for an energy transfer, may produce a disturbance in the electronic cloud of the former, which effects a radiationless transition into a lower quantum state. Again, at normal temperatures, the law of conservation of momentum permits only transitions into a lower quantum state, which in energy lies very near, so that the energy difference which has to go into relative kinetic energy of the collision partners will be small. Such transitions are of great importance for the production of atoms in those excited states called metastable states. These metastable states are states which lie higher than the ground state but are rarely populated directly by the absorption of a quantum of light. The reason is that the particular changes in the electron configuration required for the transition between the ground state and the metastable state cannot easily be produced by light. However, a transition between an excited state and a metastable state becomes much more probable as a result of a collision. This transition is called a radiationless transition because no absorption or emission of light takes place. Therefore, indirect formation of metastable states can be quite efficient. Metastable states of atoms have a natural lifetime about a million times longer than the natural lifetime of normally excited states. This is the case because transitions with light emission from the metastable state into the ground state are just as rare as the reverse process, namely, the population of a metastable state by an absorption act. Still, it is possible to observe the light emission from metastable atoms when the concentration of atoms in this state is high.

The best way to do this is to observe the afterglow immediately after the exciting irradiation is turned off. The duration of the afterglow is a measure of the lifetime of the metastable state. For some species of atoms it may last a thousandth of a second; for others, as long as several seconds. This kind of luminosity has received the name phosphorescence. The long lifetime of the metastable atoms makes the phosphorescence very sensitive toward any kind of quenching impact—even the rare ones. This has to be kept in mind in discussing another quenching process—namely, the one in which the excitation energy is utilized for the chemical reaction of the colliding particles. In principle, chemical reactions are radiationless transitions between electron clouds. They involve changes in the system of the so-called valence electrons. Thus, for the chemical transitions of electronic clouds, the law of conservation of momentum, as mentioned above, imposes the same kind of restrictions on the energy exchange with the heat motion of the heavy particles. The principal difference between the radiationless transitions of chemistry in which some of the electrons—the valence electrons—move around two or more nuclei, and those occurring during collisions of non-reacting atoms, is caused by the fact that in chemical reactions, molecules are made or changed. We will have to outline how this affects optical phenomena.

As a matter of convenience, we use a diatomic molecule to exemplify the differences between quantum transitions involving molecules and those involving atoms. A diatomic molecule has for each bond one pair of electrons which revolve around both nuclei. Electrons have a magnetic moment. Two electrons are paired and exert attraction on the two constituents of the molecule only when the magnetic moment of each electron in the pair points in an opposite direction. When they point in the same direction a repulsive force results. In principle, these electronic clouds around the nuclei of diatomic molecules behave very similarly to those around atoms. They have quantized excited states and optical transitions between these. Even metastable states exist in many molecules. In the metastable state two electrons of one pair have their magnetic moments in the same direction; these are so-called antibonding electrons. If the molecule was held together by one bond, a transition into a metastable state means dissociation into two atomic radicals. If more than one bond exists, the molecule need not dissociate upon a transition into the metastable state with the corresponding destruction of one bond. Instead it may acquire the quality of a biradical, i.e., a molecular radi-

cal, which now can further bind two other atomic or molecular radicals. The main difference between atoms and molecules is that the latter, in addition to quantized states of the electronic system, also have quantized states of the heavy particles in the molecule. These states result from the quantization of the energy of rotation and vibration of the heavy particles. This rotational and vibrational motion about the center of gravity of the system is essentially thermal agitation. This energy can, therefore, be quickly dissipated into general heat movement by collisions. The rotational movement is affected very little when the electronic cloud of the molecule is excited by light absorption. This has to be expected because a change in the rotational energy means a sudden change in the momenta of the heavy particles. As was mentioned previously, only small changes of this type are possible during the short time required for the transition of the light electrons from one quantum state to another. However, the situation is different for the vibrational movement. The equilibrium distance of the two atoms in the molecule is smaller the greater the binding energy of the molecule. If now the electron cloud is suddenly changed by an electronic transition, there may be a large or a small change in the binding energy depending upon the particular conditions. For instance, if the binding energy is weakened, then the equilibrium distance between the atoms in the molecule will be increased. But, since the heavy particles can not appreciably change their positions or their velocities during this transition, the particles find themselves at the old distance, which is no longer the proper equilibrium position for the excited state. They then start to oscillate about their new equilibrium distance. Thus, in some cases much, and in other cases little, oscillatory energy is transferred to the heavy particles as the result of an electronic transition. The variability in the amount of energy which the vibrational motion can acquire as the result of an electronic transition is the main reason for the difference in the general appearance of molecular spectra as compared to atomic spectra. Thus, in molecules, not line spectra but band spectra occur. In effect a single quantum state of an atom will, in the molecule, be replaced by many states. These differ from each other by the amounts of vibrational and rotational energy which they contain.

The fluorescence spectra will have longer wavelengths than the absorption spectra because, in electronic transitions from the excited to the ground state, the equilibrium distance changes and the mole-

cule acquires vibrational energy, which is unavailable for emission and is dissipated as heat from the ground state. The conditions become simple when fluorescence is observed at high pressures or in condensed systems, e.g., in solutions or solids. In such cases the extra vibrational energy, given to the molecule when it is excited, is lost before light emission takes place and only transitions from the non-oscillatory excited state can occur.

Energy transfer by sensitized fluorescence has been observed in molecules as well as in atoms. Since Terenin's early work in Russia more than 20 years ago, many studies have been made of the sensitized fluorescence of dyestuffs in solution. Livingston and co-workers, who systematically studied the optical properties of chlorophyll solutions in detail, observed that even at very low concentrations of chlorophyll *b* and *a* the former transferred its energy to the latter.

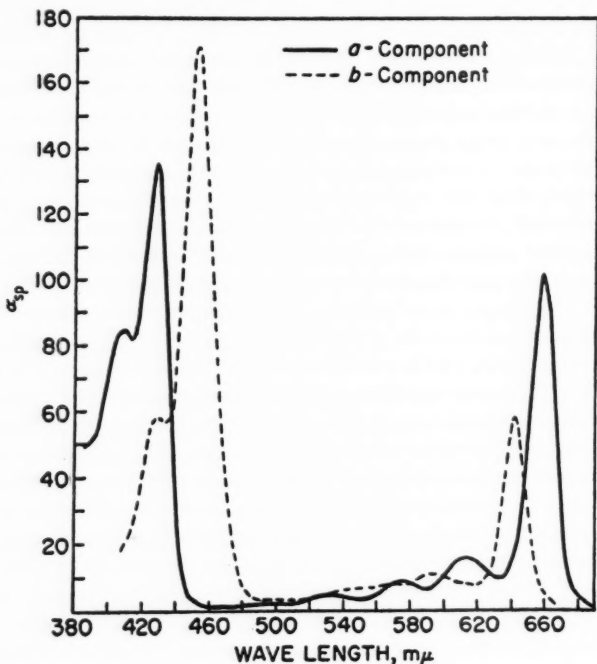


FIGURE 2

Figure 2 shows the absorption spectra of these two dyes. The absorption maximum in the red of chlorophyll *a* lies at somewhat longer wavelengths than that of chlorophyll *b*. A quantitative theory of sensitized fluorescence in molecules by Foerster has shown that the more the fluorescence spectrum of a directly excited molecule overlaps the absorption spectrum of an indirectly excited one, the greater is the efficiency of the transfer. The fluorescence spectra of the two dyes lie on the long wavelength side of their red absorption peaks. The maximum intensity of the *fluorescence* of chlorophyll *b* nearly coincides with the maximum in the *absorption* spectrum of chlorophyll *a*. This is just the condition which favors an efficient energy transfer.

French and co-workers at the Carnegie Institution and Duysens in Holland studied energy transfer in plants where the concentrations of the pigments are very high. They predominantly found fluorescence of chlorophyll *a*, regardless of whether the light was absorbed by chlorophyll *a* or by one of the other plant pigments present. Thus, the transfer of energy to chlorophyll *a* occurs by the process of sensitized fluorescence.

We now reconsider those radiationless transitions in the electronic system of the valence electrons during collision, which we have called chemistry. First, the case of chemical reactions between non-excited particles: Everyone knows that even those reactions in which a great amount of energy is liberated rarely start at low temperatures. For instance, to start a fire one has to light it. To use a term of physical chemistry, a "heat of activation" is needed. The precondition for the radiationless transitions of chemistry is that the reacting species attain spatial configurations and the heavy component particles have velocities which satisfy equally well the state of the collision partners before the chemical change and the state of the new compounds immediately after the chemical reaction. Then, only a rearrangement of the light particles, i.e., of the valence electrons, is required to complete the chemical reaction. In practically all cases, energy is needed to reach this critical constellation of the heavy particles. In the work on reaction kinetics by Eyring and others, this critical constellation is called the "activated state." The electronic transitions themselves will, nevertheless, change the potential energy of the heavy nuclei because of changes in the equilibrium distances between the particles, as discussed previously. When the reaction liberates energy, i.e., when it is exothermic, the potential energy will rise. Conversely, when the re-

action absorbs energy, i.e., when it is endothermic, the potential energy will be lowered. But in either case the heat of activation borrowed from the thermal energy must be given back to the pool of thermal motion.

Similar considerations must be applied to the utilization of excitation energy of atoms or molecules in photochemical reactions. These impose severe restrictions on the possibility of storing the excitation energy in its entirety as chemical energy.

Let us consider the possibility that the excitation energy cooperates with the thermal energy in such a way that the latter lends the energy for activation. In that case, the photochemical quantum yield becomes temperature dependent (for photosynthesis, such a temperature dependence of the yield does not exist). Furthermore, the condition has to be fulfilled that thermal energy is available for the impact between the light-excited particles and the reactants before these light-excited particles lose their energy in the form of radiation. For this to occur at room temperature, even when the heat of activation is very small, the concentration of the reactants must be very high—many times greater than the actual concentration of the reactants in photosynthesis. Therefore, we have to discard such a possibility. We are forced to conclude that the light quantum itself provides the energy necessary for activation. Thus, an amount of energy, at least equal to the activation energy, is lost for storage as chemical energy. Indeed, the activation energy for a photochemical process may be considerably higher than for a corresponding thermal reaction. Such losses into heat are only one type of the many which must occur in photosynthesis. The heat losses occurring in thermal reactions of radicals and other unstable intermediates are far greater. Thus, Burk and Warburg's claim that the total light energy can be stored as chemical energy can not be accepted. Since in photosynthesis the light is absorbed by poly-atomic dye molecules, I wish to emphasize that all the principles discussed previously remain unaltered when applied to this more complicated case. There is, however, one additional consideration. Poly-atomic molecules are able to perform radiationless transitions to lower quantum states by an internal process in which the energy difference between the originally excited state and a lower state is transformed into vibrational motion of the heavy particles. At high gas pressures or in condensed systems, this vibrational energy is rapidly dissipated. This effect, called internal conversion, also depends on the particles' reaching a critical constellation.

When the particular critical constellation can be reached very quickly, the transition into a lower quantum state will prevent the emission of fluorescence (by a radiative transition) from the higher excited state. Emission from the lower state may still occur whenever this state is an excited electronic state. Indeed, in all organic dyes, such internal conversions occur between the second excited state and the first one. By internal conversion, the energy difference between the second excited state (reached by the absorption of, for instance, blue light) and the first excited state is dissipated into heat. This occurs before photochemistry can take place from the second excited state. The energy available for photochemistry is thus independent of the wavelength of the absorbed light and equal only to the energy content of the non-oscillating first (or lowest) excited state relative to the ground state. As mentioned above, the fluorescence of chlorophyll lies on the long wavelength side of the red absorption peak.

We close our general remarks on light and chemistry with a few comments on chemiluminescence. Chemiluminescence is a light emission by atomic or molecular species which have gained their excitation energy through collisions with violently vibrating molecules. Such molecules acquire for a short time an energy of thermal motion many times greater than the average. They are found in very exothermic chemical reactions. In most cases, the abnormally hot molecules dissipate their high vibrational energy by collisions. There is, however, a small chance that the energy in a collision complex is utilized for the excitation of one of the partners of the collision. The process of chemiluminescence is thus the reverse of the utilization of excitation energy in photochemical reactions. The light emission of fireflies is a well-known and well-studied example of chemiluminescence. Strehler, who has devoted much of his time to a study of light emission by fireflies, has shown with Arnold that a weak chemiluminescence of chlorophyll *a* occurs in green plants. This light emission can be observed during a dark period, immediately following a period of photosynthesis. An example of chlorophyll chemiluminescence *in vitro* was found by Linschitz. This occurs when chlorophyll is used to catalyze the thermal decomposition of certain organic peroxides.

Figure 3 shows the chemical structure of chlorophylls *a* and *b*. As indicated, these differ only in that *a* has a  $-\text{CH}_3$  (or methyl) group where *b* has a  $-\text{CHO}$  (or aldehyde) group. The chlorophylls have a so-called porphyrine structure with two special features of importance for our problem. One of these is a long phytol chain;

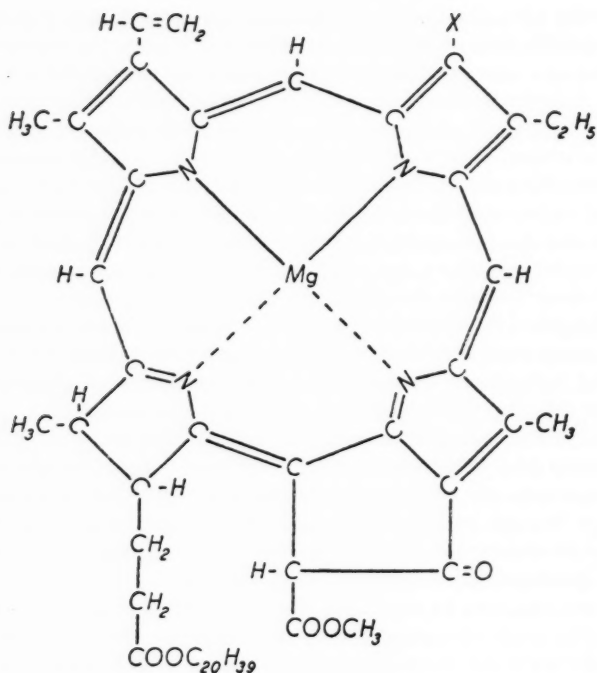


FIGURE 3

In chlorophyll a,  $\text{X} = -\text{CH}_3$ . In chlorophyll b,  $\text{X} = -\text{C}(=\text{O})\text{H}$

another is the cyclo-pentanone ring. This ring, by the way, is so connected to the other ring systems that considerable strain exists between two of its carbon atoms—those represented in Figure 4—resulting in a great influence on its chemical reactivity.

This particular ring, either in its keto or its enol form, as shown in Figure 4, has often been suspected as the most likely site of chemical changes in the chlorophyll during photosynthesis. Chlorophyll dissolved in methanol is, under certain conditions, changed by a reaction of an excited chlorophyll with a non-excited one. Livingston and I

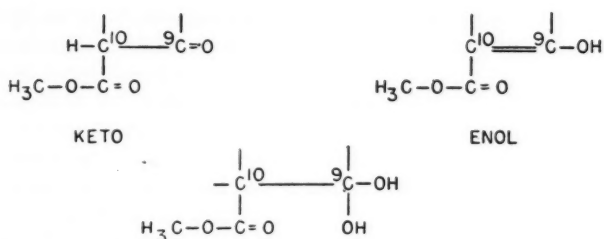
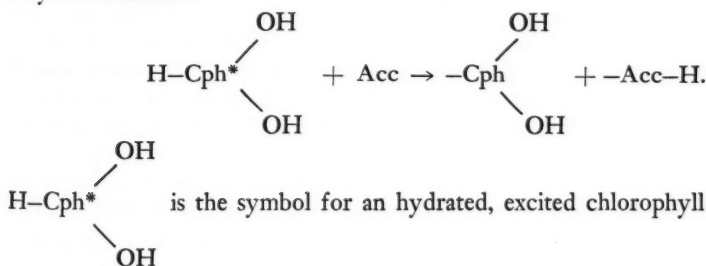


FIGURE 4

deduced the occurrence of such a reaction from the observations of a reversible bleaching of the chlorophyll by Porret and Rabinowitch. A small bleaching occurs in the light; the color is restored by a bimolecular reaction in the dark. It is assumed that an hydrogen atom is transferred from one chlorophyll to the other, whereby two so-called radicals are formed. Their back reaction restores the original molecules. The hydrogen involved in this reaction should be the labile hydrogen atom of the cyclopentanone ring.

An often-considered hypothesis postulates that, in photosynthesis, chlorophyll acts as the donor of this particular hydrogen atom, which is later replaced by an hydrogen atom from water. One version of this process appealed to me strongly for some time, but it had to be discarded, at least from the main course of photosynthesis. Still I might profitably mention it and its drawbacks, because there are indications that this process is utilized for reduction of certain oxidants under particular circumstances. It is known from a number of experiments that chlorophyll easily adds water. When a water molecule is added to the keto group of the cyclopentanone ring, the following reaction may be visualized:



molecule. Acc symbolizes a photosynthetic oxidant. After the hydrogen atom is transferred, one of the two OH groups is in effect loosely bound because its removal favors the closing of a double bond. In such a case the energy needed would not be higher than that necessary to break a weak peroxidic oxygen bond. Thus, an enzyme involved in utilization of the hydroxyl, i.e., the OH, as a source of oxygen could easily remove it. The main reason for rejecting this hypothesis is that it depicts one quantum process for the transfer of one H atom, while two quanta are needed. In addition, certain observations on the fluorescence of chlorophyll cannot be reconciled with this picture.

The phytol chain too plays an important function. This chain *per se* contains groups which make it fat-soluble. The result is that the chlorophylls are adapted to settle at the interface of protein and lipid, i.e., fatty material, as they are generally believed to do in the chloroplasts. The excited chlorophyll must be accessible to water and the compounds dissolved in it which are to utilize the excitation energy of the chlorophyll for photochemical purposes. Thus, we visualize the following model. The main ring system may not be only adsorbed at the protein but imbedded in it. This leaves the cyclo-pentanone ring exposed so that it may have contact with a layer of water between the protein and the lipid. The long phytol chain will penetrate into the lipid. The model resembles the structure of a micelle. The information obtained by electron microscopy about the laminar structure of chloroplasts is in agreement with this model.

We recall from our general discussion that the fluorescence of complex molecules can be partially or entirely quenched by radiationless transitions into the next lower quantum state. Since for dyes in solution only the first excited state is responsible for the fluorescence, its quenching (in absence of other quenching processes) can only be achieved by radiationless transitions into a metastable state. Transitions from this metastable state to the ground state are very rare. Since all dyes studied so far have a metastable state, no spectroscopist assumes that chlorophyll is the exception. Therefore many attempts have been made to find the phosphorescence of chlorophyll, which would result during transitions from the metastable state to the ground state—all of them have been in vain. The most probable conclusion is that the energy of the metastable state is lower than expected, so that the phosphorescence emission has its spectrum far in the infra-red region where it is not easy to detect. Recently, Livingston has found evidence that a metastable state of chlorophyll

actually exists. His method was to irradiate chlorophyll solutions with very strong light flashes, so that all the chlorophyll molecules in his sample were thrown into excited states. A large number of them will then fall into the metastable state and remain there for the duration of the natural lifetime of this long-living state. Instead of searching for the afterglow of phosphorescence, Livingston studied the absorption spectra right after the flash. He found that practically all of the molecules lost their normal absorption spectrum and that an entirely new one appeared—obviously that of the chlorophyll species in which the metastable state was the ground state.

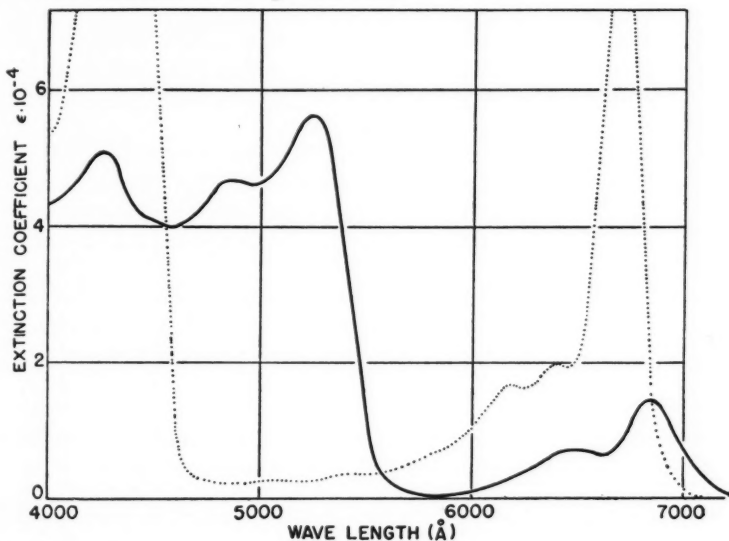


FIGURE 5

The dotted line of Figure 5 outlines the absorption spectrum of chlorophyll *a*, while the solid one shows an absorption spectrum not entirely, but very similar to, the absorption spectrum of chlorophyll *a* in its metastable state.\*

\* The solid line actually represents the absorption spectrum of a negative ion of chlorophyll *a* observed by Weller in Livingston's laboratory. The reason why it is so similar to the spectrum of the metastable chlorophyll has been discussed in Weller's paper. A picture of Livingston's spectrum is not available at the moment; it will soon appear in print. The use of Weller's spectrum has the advantage of showing an absorption peak in the long wavelength region, just beyond the

The time needed for the reappearance of the original green color, and for the vanishing of the new absorption spectrum, is a measure of the lifetime of the metastable state. It turned out to be between  $1/100$  and  $1/1000$  of a second under the most favorable conditions. This important proof of the existence of a metastable state in chlorophyll is a strong support of the conclusions, based on older evidence, namely, that in chlorophyll solutions (under certain conditions) as well as in photosynthesizing cells, the transition into the metastable state, and not the quenching as a result of photochemical reactions, limits the fluorescence intensity.

Let us discuss the evidence obtained from studies on chlorophyll *in vitro* made by Livingston and also by the Russian scientist, Krasnowskii. Chlorophyll *b* and chlorophyll *a* fluoresce in organic solvents; but the fluorescence yield, i.e., the ratio between the number of re-emitted quanta and the number of absorbed quanta, is always less than one. The highest value,  $1/4$ , has been found for a solution of chlorophyll *a* in methanol. Fluorescence yields have been measured under conditions in which photochemical reactions responsible for quenching have been avoided. The clearest indication that the low yield was not caused by chemical processes is that in pure and carefully dried benzene the fluorescence was practically absent. Chemical reactions of the stable benzene with excited chlorophyll molecules are not possible. The fluorescence reappeared when small amounts of water were introduced. Adsorption of water by the chlorophyll molecules is presumed responsible for this effect. Adsorption of certain other substances has a similar influence. Thus the adsorption appears to delay the radiationless transition into the metastable state.

Several experiments with fluorescent dyes have shown that the time required to reach the critical point for a radiationless transition into a metastable state is very sensitive to small changes in the structure either of the dye molecule itself or of any molecule with which it may be in contact. The low fluorescence yield in the absence of photochemical processes is thus satisfactorily explained by transitions into the metastable state.

Is the same explanation possible even when a competing photochemical process occurs with a high quantum yield? Yes, the quench-limit of Livingston's spectrograph. We therefore do not know, but surmise from the general appearance, that such a peak will be present in the spectrum of the metastable chlorophyll. There is no doubt that the absorption continues into the long wavelength region.

ing of the fluorescence of the dye molecule can still be attributed to trapping in the metastable state provided the following conditions are fulfilled:

(1) The concentration of the reactants must be so small that impacts with the dye during the brief lifetime of its excited state occur too infrequently to have an influence on the fluorescence intensity; and

(2) Collisions between the dye molecule in the metastable state and the participating molecules must result in a reaction.

Several systems are known which fulfill these conditions. I mention one in which chlorophyll is involved; namely, the photo-oxidation of thiourea sensitized by chlorophyll, first observed by Gaffron. The reaction has a quantum yield of about *one* even when the oxygen concentration is quite small. The kinetics of the reaction led Gaffron to assume that a relatively long-living energy-rich particle was involved. We now know this is a chlorophyll molecule in the metastable state. Livingston demonstrated that, while impacts between oxygen and the excited chlorophyll molecule resulted in a quenching of the fluorescence, impacts between the thiourea and chlorophyll molecules did not. On the other hand, the reaction retained its high quantum yield even when the oxygen concentration was reduced to such a small value that it no longer quenched the fluorescence.

The situation is very similar in green plants. The fluorescence yield can remain unchanged when, through lack of carbon dioxide, only a small part of the photochemical apparatus is utilized for photosynthetic purposes.

Figure 6 shows a saturation curve of photosynthesis for a leaf in normal air. Also shown is the saturation curve in an atmosphere of nitrogen containing only one- or two-tenths of a per cent of oxygen and the same low concentration of carbon dioxide as in normal air (.03%). The saturation in nitrogen is, under these conditions, caused by carbon dioxide limitation. This means that, at an intensity twice as great as the minimum intensity producing saturation, half of the photosynthetic apparatus stays idle. Still, the corresponding fluorescence curve rises linearly with light intensity far into the saturation region, i.e., the fluorescence yield remains constant. The yield has a value of a few tenths of one per cent. The corresponding curves in air exhibit a different behavior. Saturation is reached at lower light intensities because oxygen competes as an oxidant with the normal photosynthetic oxidants as soon as the concentration of the latter

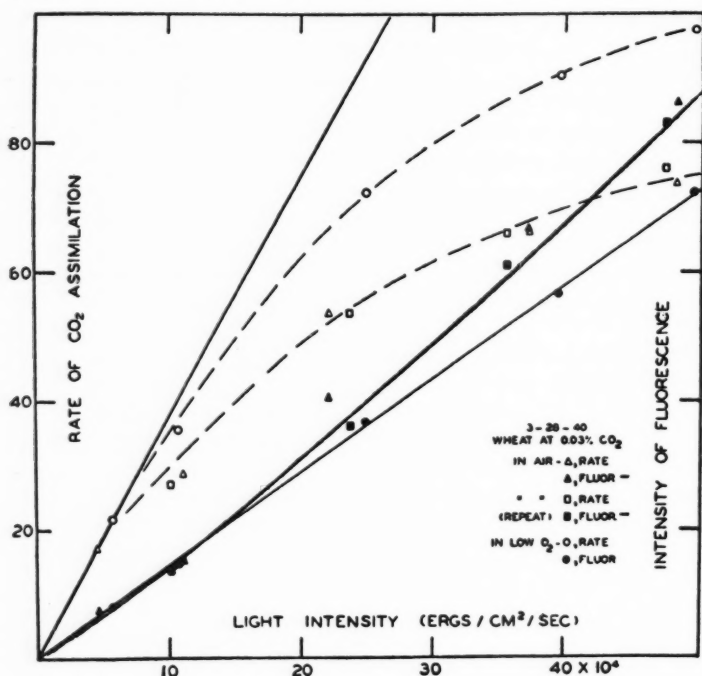


FIGURE 6. Carbon dioxide assimilation and intensity of fluorescence versus incident light intensity. A comparison of low and normal oxygen pressures for wheat at 0.03 per cent carbon dioxide.

becomes small. It is reduced to hydrogen peroxide. Experiments in air entirely free of carbon dioxide have shown that the actual rate of oxygen consumption required for the formation of the peroxide is much smaller than the difference between the saturation rates in air and in nitrogen.

This result, together with ample other evidence, supports the hypothesis that all kinds of photo-oxidation of carbohydrates and other organic materials produce substances which are adsorbed at the chlorophyll, raise its fluorescence, and act at the same time as a protective cover. This cover restricts the access of oxygen to the excited chlorophyll molecule thereby checking excessive photo-oxidation.

The fluorescence yield of the chlorophyll increases by a factor of 2 or 3 under these conditions. Phenylurethane, a narcotic-like substance, when used in concentrations high enough to suppress photosynthesis entirely, also produces a 2 or 3 fold increase in the intensity of the fluorescence. It is significant that conditions have not been found which make this yield appreciably greater. It is my opinion that the production of an inhibitor of photosynthesis by photo-oxidation is a self-protecting mechanism. Our plants thereby manage to prevent destructive photo-oxidation when they are irradiated in bright sunlight in normal air, whose concentration of carbon dioxide is far too low to keep the whole photosynthetic apparatus occupied at full capacity.

Attempts have been made to explain these results by the introduction of special hypotheses. For instance, it has been postulated that, when carbon dioxide is limiting, fast back-reactions of primary photo-products keep the photosynthetic apparatus supplied with material to be reduced. Other explanations have been based on the concept of the photosynthetic unit. In my opinion, however, these attempts have failed to explain why the fluorescence yield in green plants does not become higher than about one per cent. This is even the case when photochemical activity has stopped completely.

To emphasize the similarity between the behavior of the fluorescence of chlorophyll *in vivo* and *in vitro* under similar influences, I shall discuss certain experiments with quinone in plant cells and in organic solutions of chlorophyll.

Collisions between quinone molecules and excited chlorophyll molecules quench the fluorescence in organic solutions as well as in the plant cells. In both cases the existing evidence indicates that, as a result of a quenching impact, a semi-quinone is made. As mentioned before, the quinone reduction in green cells is analogous to photosynthesis. The hydrogen used for the reduction, as well as the oxygen evolved, comes from the water. Since quinone is a strong oxidizer, the transfer of one hydrogen atom from the water to the quinone requires less energy than for the corresponding transfer to the photosynthetic oxidant. Indeed, no difficulties exist in assuming that in the case of quinone the absorption of one photon suffices energetically to perform the transfer. The actual quantum yield measurements indicate that two quanta are used. That there is an apparent disagreement between the quantum requirement predicted and that observed is not unexpected. The concentration of quinone which can be toler-

ated without causing damage to the chlorophyll-protein complex is so small that impacts between excited chlorophyll and quinone are rare. Usually the experiments start with a quinone concentration of about  $10^{-4}$  molar. During the experiments this decreases due to the photochemical reduction of quinone to hydroquinone. The quenching observed in the presence of  $10^{-4}$  molar quinone is about 20%. Brugger in our laboratory observed quenching up to 60% by raising the quinone concentration; even prompt removal of the quinone by washing of the cells did not fully restore the original fluorescence yield. Our conclusions are: if the one quantum process for a transfer of one hydrogen atom to quinone is energetically possible and it actually occurs as the quenching of the chlorophyll fluorescence indicates we visualize that this process corresponds to the one rejected above. Certain other results support this view. However, the direct utilization of excitation energy of the chlorophyll by quenching impacts is rare and thus the bulk of the reaction proceeds with the utilization of the energy of the metastable state in a two quanta process.

Any model, which is designed to explain photosynthetic reduction, must also describe quinone reduction. The model which I wish to present requires the introduction of certain plausible hypotheses. The most I can hope is that the general picture is correct. The cause of the great sensitivity of dyes in metastable states toward oxygen may lie in their characteristic structure. Certainly the long lifetime of the metastable state (long compared with the lifetime of the unstable excited states of chlorophyll) allows time for the right kind of impacts to occur even though they are rare. This implies that the metastable state must be insensitive toward impacts with the wrong substances. We must be concerned about impacts with oxygen. All dyes in their metastable states are exceedingly sensitive toward oxygen, and the reactions involved lead to oxidation processes. For these reasons I have maintained the point of view that the primary photosynthetic steps must include only substances present in concentrations high enough to win in the competition with dissolved oxygen for the energy of the metastable state. Livingston's observations show that the metastable state of chlorophyll dissolved in organic solvents is as sensitive toward oxygen as expected. Small concentrations of oxygen shorten the lifetime considerably.

The reason for the great sensitivity of a dye in its metastable state toward quenching by oxygen may lie in its characteristic structure—that of a system of conjugated double bonds. As I have discussed,

the transition of a dye to a metastable state is equivalent to a transition of an electron pair from a bonding to an antibonding state. In the system of conjugated bonds certain of the electron pairs, so to speak, flow around the ring system. The spin transition of one electron pair in the ring will thus weaken all the carbon-carbon bonds and only to a small degree each bond individually. A collision at any place in the ring system with an oxygen molecule may localize the disturbance by the formation of a peroxidic compound of the well-known moloxide type. The main ring system of the chlorophyll in the chloroplasts might be protected against such impacts with oxygen if it were imbedded in the protein. This particular reaction with oxygen could not occur in that part of the cyclo-pentanone ring which is not conjugated with the main ring system. The cyclo-pentanone ring might, however, be sensitive toward another type of reaction with oxygen, namely, one in which the oxygen is reduced in the manner of a Hill reaction. The interference between oxygen and photosynthesis proper might occur here and be less critical.

The cyclo-pentanone ring must be of special significance in the configuration of the metastable state of chlorophyll. The biradical character of its absorption spectrum, pointed out by Weller, is understandable if chlorophyll, unlike dyes in general, can possess a localized, opened double bond. The predestined position for the opening of a double bond is the cyclo-pentanone ring. To visualize this consider the enol form of the cyclo-pentanone ring. This has a double bond isolated by position and differing in energy from all the other double bonds in the conjugated ring system. Tension in the ring makes it weaker than the other double bonds. For this reason, I assume a localized breaking of this bond by the transition into the metastable state. If such a break occurs, we can understand why the energy of the non-oscillating metastable state must be quite low. The spins of the electron pair are now parallel and repel each other. The most stable position should be that in which the cyclo-pentanone ring is distorted in such a way that the spins approach positions at right angles to each other. Such a transition into the metastable state, occurring in a planar cyclo-pentanone ring, will cause violent distortion vibrations about the new, non-planar equilibrium positions of the heavy particles. The energy of these oscillations will be dissipated quickly. The radiative transition from the non-oscillating metastable state will occur to a high vibrational level of the ground state. The energy of these torsional oscillations of the ground state will be

unavailable for the light emission process, making the quanta still smaller and the wavelengths of the emitted light longer.

A study of the various spectra of chlorophyll leads me to believe that a chlorophyll molecule in its lowest metastable state should be able to "collect" energy of excitation originally received by any of a hundred or even five hundred chlorophyll molecules in its neighborhood—thereby becoming excited to a higher state of its electronic system. At high intensities of irradiation, this estimate of a few hundred "collecting" chlorophyll molecules is more than sufficient to provide excitation energy to the metastable chlorophyll molecules and thereby to sustain a reasonable rate of photochemistry.

At low light intensities of irradiation one might anticipate difficulties since, although the lifetime of the metastable state is long, it may not be long enough. In such a case the return to the ground state via radiationless transitions, or by any other mechanism, might occur before the chlorophyll molecule has a chance to receive its second quantum from the "collecting" chlorophyll molecules. The observed rate of photochemistry will then be unaccountably low, which is not the observed fact. To circumvent this difficulty one could assume that the natural lifetime of a chlorophyll molecule in its metastable state is of the order of a second. Such an assumption need not be in direct contradiction to the observation of Livingston, which placed this lifetime in the order of one thousandth of a second. It turns out that the lifetime of the metastable state of dissolved chlorophyll is greater, the greater the viscosity of the solution. It is not inconceivable that, when a chlorophyll molecule is bound to its protein moiety, its lifetime may be considerably lengthened. Yet, the lifetime demanded by this hypothesis is uncomfortably high.

We supplement our picture with the assumption that the lifetime of the lowest metastable state can be prolonged by attachment of the photosynthetic reactants to form a complex in contact with the chlorophyll. After all, in this particular case, the metastable state is a biradical. It can easily undergo chemical reactions with the molecules destined to form the complex. In this manner its biradical character is conserved, the absorption spectrum remains practically unchanged, and the radiative transition probability into the normal ground state is very much reduced. In effect the electronic part of the metastable state will be lowered and the energy stored to a great extent as chemical energy. This hypothesis is of course made *ad hoc*, but it has a certain plausibility in its favor. Experiments with single, strong light

flashes lend support. Indeed, before the absorption spectrum of the metastable state was known, these experiments had induced me to consider the hypothesis of piling the energy of two absorption acts on top of each other by sensitized fluorescence.

The picture I have presented on the role of the metastable state of chlorophyll allows me to reinterpret some of my old concepts in photosynthesis. These arose as a result of the early experiments of Emerson and Arnold on flash photosynthesis. Irradiation of algae with periodically repeated light flashes of  $10^{-5}$  seconds duration results in an evolution of oxygen which reaches a maximum per flash when the dark interval between flashes is of the order of  $1/100$  second or longer. When the dark interval is reduced below  $1/100$  second, the yield per flash decreases.

Of the different interpretations which have been attempted I mention only my own because it is connected with the hypothesis under discussion. My view has been that the primary photo products are unstable and must be stabilized by an enzyme present in a limited concentration. The photochemical products, which are produced when all the stabilizing enzyme molecules are occupied, will disappear by back reactions before they are stabilized. The duration of  $1/100$  of a second for the dark period necessary to reach the maximum yields was the working period of this stabilizing enzyme.

Recently, experiments made by Tamiya and by Gilmour *et al.* with light flashes of  $10^{-3}$  seconds duration reproduced the results of Emerson and Arnold only at relatively low flash intensities. Raising the intensity further resulted in an increase of the yield per flash; the observed flash saturation was higher than that observed by Emerson and Arnold. Furthermore, the dark periods required to attain flash saturation were much longer than  $1/100$  second. Tamiya interpreted this to mean that Emerson and Arnold had not reached true flash saturation. Ehrmantraut and Rabinowitch repeated and extended Emerson and Arnold's work with flashes of  $10^{-5}$  seconds duration. They not only confirmed Emerson and Arnold's results but showed that low flash intensity was not responsible for the low yield. I concluded (as did Gilmour *et al.*, who suggested a different mechanism) that the discrepancy in the results must be ascribed to the difference in flash durations. For instance, let me change my old interpretation and assume that the working period of the stabilizing enzyme is only  $10^{-4}$  seconds. Then, it can work only once during a flash of  $10^{-5}$  seconds but several times during the illumination by a flash of  $10^{-3}$  seconds. The

period of  $1/100$  of a second can be reinterpreted as the time required for all the other enzymes to perform their work at later stages of those chemical reactions of photosynthesis which follow the stabilization reaction. Suppose that an acceptor molecule for a hydrogen atom, water and an enzyme must all be part of the complex that is attached to the metastable chlorophyll in order to effect the transfer of an hydrogen atom to the acceptor and to bind the hydroxyl so loosely that it can react enzymatically and lead to oxygen evolution. Then, only those metastable states localized in an assembled complex will utilize the added excitation energy and complete the reaction. When the enzyme is not present in the complex, the chlorophyll will revert to its ground state and the "collected" excitation energy will be dissipated. The yield from flashes of sufficiently high intensity, and of duration shorter than the  $10^{-4}$  second working period of the stabilizing enzyme, will thus be a measure of the number of these enzyme molecules in the system. On the other hand, flashes of  $10^{-3}$  second duration will permit the assembly of the complex several times during the flash and, therefore, give higher yields.

We have now come a long way in our discussion. You have seen how an understanding of the phenomena in this field of biology is intimately connected with the principles of physics and chemistry. Recent advances in other laboratories, especially all the work of Livingston and co-workers and that of Duysens, have been of the greatest importance in forming a basis for our conclusions. Experimental observations made in our laboratories by our students and co-workers through the years have shaped our interpretations. Of the very recent results, I mention in this connection the experiments of Allen with single light flashes and of Brugger on chemiluminescence. Strehler's new results—he joined our group after his pioneering work on chemiluminescence with Arnold—fall into the same category. Vivid discussions in our whole group have been most stimulating to me. The influence of my friend and colleague, Gaffron, on this contribution, as on all other work of our group, is well known, especially to those who know the literature of photosynthesis. I use this occasion to state that I owe him special gratitude for his patience in trying to instill in me some knowledge of biochemistry. He has forewarned me that we physicists unconsciously tend to oversimplify the problems of biology. I have tried to heed his warning, and I can only hope that I have at least partially succeeded.

# Count Rumford on Photosynthesis

SANBORN C. BROWN

EARLY in the year of 1781, Benjamin Thompson (later to become Count Rumford) found time from his busy life as British Under Secretary of State for the North American Colonies to devote considerable time to philosophical pursuits. Among his many interests at the time were measurements of the strength of materials, and in particular the strength of single strands of raw silk. To relate the strength of materials to physical properties, Thompson undertook to measure the specific gravity, the diameter, and the strength of silk in a fairly elaborate series of experiments which he carried on sporadically for about six years.

Several factors are of historical interest in connection with Thompson's study. First of all, the paper describing these experiments which he sent to the Royal Society, and which was read before the Royal Society in January 1787, was for some reason never published, and is therefore not found in any collection of Rumford's works. It exists in manuscript form in the archives of the Royal Society.<sup>1</sup> Secondly, these experiments on the strength of silk were only part of a more elaborate study of the strength of a large number of materials, a subject which occupied Thompson for a great many years. This larger study was also never published because of a curious incident in Rumford's life, in which his private papers were confiscated by what he believed to be official orders. He describes the event in part:<sup>2</sup> "On my return to England from Germany in October 1795, after an absence of eleven years, I was stopped in my post-chaise, in St. Paul's churchyard, in London, at six o'clock in the evening, and robbed of a trunk which was behind my carriage, containing all my private papers, and my original notes and observations on philosophical subjects. By this cruel robbery I have been deprived of the fruits of the labour of my whole life; and have lost all that I held most valuable. This most severe blow has left an impression on my mind, which I feel that nothing will ever be able entirely to remove. It is the more painful to me, as it has clouded my mind with suspicions that never can be cleared up."

From these unpublished notes and writings came Thompson's published paper<sup>3</sup> on "Experiments on the Production of Dephlogisticated Air from Water with Various Substances." His work on strength

of materials led him to try to determine the density of silk with a hydrostatic balance. In using this method he was impressed by the amount of air given off by silk when kept under water, and this led him to study the effects of a number of substances which apparently gave off oxygen when irradiated by sunlight. His paper on this subject was read before the Royal Society on 15 February 1787, within a few weeks of his unpublished paper, and printed in the *Philosophical Transactions* of that same year.

Many of the natural philosophers of the day had been impressed by a paper published earlier in 1782 by John Ingenhousz<sup>4</sup> in which he demonstrated that plants, living in water, gave off oxygen when subjected to sunlight. In attempting to explain the apparent production of oxygen by raw silk immersed in water, Thompson repeated and extended many of Ingenhousz's experiments. Ingenhousz's technique was to grow his plants in inverted glass globes full of water, collecting gas given off and testing it for its oxygen content. Thompson started to carry out his experiments in this fashion but found it difficult to compare volumes of gas emitted with this setup. He therefore modified the arrangement so that the gas displaced water which could be easily collected as an overflow and therefore measured during the progress of the experiment. When he had collected the volume of gas he desired, he used what was then the standard test for oxygen<sup>5</sup> by measuring the diminution of volume of the gas when mixed with known amounts of nitrous oxide.

The technique consisted of transferring the gas, produced by the action of the sunlight on the material being studied, to a standard measure in a water trough. The standard measure was first filled with water, inverted in the trough, and then the gas to be tested was bubbled into the measure, displacing the water. The measure was equipped with a slider to seal off the gas at a given volume. The gas was then transferred by the same method of displacement of water to a calibrated tube called a eudiometer. The "goodness" of the air was then "proved" by adding to the gas in the eudiometer three or four measures of "nitrous air," and from the diminution of volume of the mixture in the eudiometer, the oxygen content of the original gas was calculated.

As was mentioned previously, Thompson started out by studying the oxygen that appeared to be produced by the action of sunlight on raw silk.<sup>8</sup> He first showed, in a controlled experiment, that the action of sunlight was essential and that in the same length of time a like

quantity of silk kept in the dark did not produce any measurable quantity of gas. He showed that heat from a stove, without light, did not produce any gas, but that light from lamps and candles using reflectors for intensification yielded measurable quantities of oxygen. He demonstrated that the light and not the heat was the essential ingredient in sunlight by collecting oxygen when his globes of silk in water were exposed to sunlight while packed in ice. He tried a great many different kinds of substances, such as sheep's wool, eider down, rabbit fur, cotton wool, linen, and human hair and noticed that only when the water appeared to turn greenish did he collect appreciable quantities of oxygen. He concluded "that the *green matter* acts a very important part in the production of this air." To show that the production of oxygen was not a purely mechanical separation of dissolved air by adherence to any available immersed body, he used spun glass irradiated by sunlight and found that spun glass did not produce a gas purer in oxygen than air.

Both Priestley<sup>6</sup> and Ingenhousz<sup>4</sup> had found that leaves and plants gave off oxygen only so long as they were alive, and that they ceased to produce "Dephlogisticated air" when they died. Rumford continued his experiments much longer in time and found that although oxygen was produced in diminishing amounts as the plants and leaves got older, if he waited for some time after the leaves had ceased to give off gas, the water turned greenish and the gas supply was re-evolved. His paper excited considerable criticism and Sennebier<sup>7</sup> in Paris repeated the entire set of experiments two years later, coming to the conclusion that they were completely wrong and that "it was probably the air contained in the water which separated in the Count's experiments."

Thompson did not try to postulate any definite mechanism for the production of oxygen from the materials which he studied. His paper was of the observational type which was the rule rather than the exception in the periodical literature of the time. He concluded his paper with the following observations:

"Perhaps all the appearances above described might be satisfactorily accounted for, by supposing the air produced in the different experiments to have been generated in the mass of water by the *green matter*; and that the leaves, the silk, etc., did no more than *assist it in making its escape*, by affording it a convenient surface to which it could attach itself, in order to its collecting itself together, and taking upon itself its elastic form.

"The phaenomena might likewise be accounted for by supposing the *green matter* to be a vegetable substance, agreeable to the hypothesis of Dr. Priestley, and that attaching itself to the surfaces of the bodies exposed in the water, as a plant is attached to its soil, it grows; and, in consequence of the exertion of its vegetative powers, the air yielded in the experiment is produced.

"I should most readily have adopted this opinion, had not a most careful and attentive examination of the green water, under a most excellent microscope, at the time when it appeared to be most disposed to yield pure air in abundance, convinced me, that, *at that period*, it contains nothing that can possibly be supposed to be of a vegetable nature. The colouring matter of the water is evidently of an animal nature, being nothing more than the assemblage of an infinite number of very small, active, oval-formed animalcules, without anything resembling *tremella*, or that kind of *green matter*, or water moss, which forms upon the bottom and sides of the vessel when this water is suffered to remain in it for a considerable time, and into which Dr. Ingenhousz supposes the animalcules above-mentioned to be actually transformed."

#### REFERENCES

1. Guard book No. 82, Royal Society. Decade IX, No. 23.
2. Rumford, *Complete Works*, (Boston: American Academy of Arts and Sciences, 1870) I, 132, footnote.
3. B. T. Thompson, *Phil. Trans.*, LXXVII (1787), 84.
4. J. Ingenhousz, *Phil. Trans.*, LXXII (1782), 426.
5. For example see G. Adams, *Lectures in Natural and Experimental Philosophy*, (London, 1799), I, 495.
6. J. Priestley, *Experiments and Observations on different kinds of Air*, (London, 1778), III, 284.
7. Sennebier, *Ann. de Chimie*, I (1789), 115.

# Publishing the Papers of Great Men

*A Session at the Sixty-Ninth Annual Meeting of the  
American Historical Association, 30 December 1954*

WALTER MUIR WHITEHILL, JULIAN P. BOYD,  
LEONARD W. LABAREE, L. H. BUTTERFIELD,  
WILMARTH S. LEWIS, and WALDO G. LELAND

## FOREWORD

ONE of the extraordinarily perceptive anonymous essayists contributing to *The Times Literary Supplement's* special number of 17 September 1954 concerning American writing today observed that while "there is a sense in which England is a profoundly historically minded country . . . compared with the United States historiography in England is a minor matter, a hobby, a respectable activity but not big business, not one of the pillars of the State. We have no real equivalent to the State historical societies, no historical society of the antiquity and prestige of the Massachusetts Historical Society, no great scholarly enterprises (allowing for the D. N. B. and the *Complete Peerage* and the *Victoria County Histories*) on the scale of the Washington or Jefferson papers or the promised edition of Franklin's works."

As the history of the American Academy of Arts and Sciences has been inextricably entangled with various generations of the Adams family, it is appropriate that the first number of *Dædalus* should contain some account of the edition of the Adams Papers, which is the latest of the great American scholarly enterprises of the type mentioned by *The Times Literary Supplement*. The experiences in France of John Adams "among the academicians and other men of science and letters" suggested the idea of founding the American Academy of Arts and Sciences. He served as its President from 1791 to 1814, while his son, John Quincy Adams, from 1820 to 1829, and his grandson, Charles Francis Adams, from 1873 to 1880, held the same office. The public and personal papers of these three remarkable men, and

of their wives and children, had been preserved from generation to generation with extraordinary fidelity and historical conscience, first at the old family house at Quincy, and, since 1905, on deposit (although not generally accessible to scholars) at the Massachusetts Historical Society. In the summer of 1952, Thomas Boylston Adams (III:5, who, incidentally, has continued the Adams tradition of service to this Academy into the sixth generation by becoming its Treasurer this month), as the active trustee of the Adams Manuscript Trust, appointed an Advisory Committee of historians to recommend means by which this extraordinary mass of documents on American history might readily be made available for use. The committee recommended microfilming the entire collection of more than three hundred thousand pages and permitting selected research libraries throughout the country to purchase positive copies. The launching of this project was greatly speeded by the prompt granting of one thousand dollars from the Permanent Science Fund of the Academy, and of two thousand dollars by the American Philosophical Society, which enabled the Massachusetts Historical Society to purchase the necessary equipment and get the work under way without loss of time. Thus the three oldest learned societies in the United States joined in an effort for the common good. During 1954, while the microfilming was still in progress, arrangements were completed whereby the Massachusetts Historical Society undertook to edit for publication by the Belknap Press of Harvard University Press, with advance serialization in *Life*, a selective edition of the Adams Papers. L. H. Butterfield (IV:2), formerly Director of the Institute of Early American History and Culture, Williamsburg, Virginia, was appointed Editor-in-Chief.

As the American Philosophical Society and Yale University had, in January 1954, announced their plans for the publication of *The Papers of Benjamin Franklin*, such editorial projects were an obvious subject for discussion at the sixty-ninth annual meeting of the American Historical Association, held in New York City at the Commodore Hotel, 28-30 December 1954. When requested to serve as chairman of a session upon the theme "Publishing the Papers of Great Men," I induced Julian P. Boyd and Wilmarth S. Lewis to summarize some of their experience in the long-established Jefferson and Walpole projects, and asked Leonard W. Labaree and Mr. Butterfield to give some account of their plans for the Franklin and Adams editions. Although Mr. Lewis's paper was originally prepared as a B.B.C.

broadcast (*The Listener*, 9 April 1953), it contains so much wit and wisdom that it will well bear reprinting for an American audience.

In the discussion following the papers, Waldo G. Leland (IV:2) described the role of the American Historical Association in furthering the publication of papers of great men. I am grateful to him for reducing his recollections to paper for the permanent record.

WALTER MUIR WHITEHILL

## Some Animadversions on Being Struck by Lightning

JULIAN P. BOYD

*Editor of The Papers of Thomas Jefferson*

ABOUT a quarter of a century ago J. Franklin Jameson, a very wise scholar whose indefatigable labors have placed historians, archivists, and editors everlastingly in his debt, remarked that the idea of training a young man to become an archivist in the United States was something like training him to be struck by lightning. Since then the archival profession in America has become firmly established, has grown steadily in influence and accomplishment, and has even set new standards for its ancient and respected counterpart in the old world. Our presence here this morning to discuss four multi-volume editions of papers of historic figures; the comprehensive program recently outlined by a revitalized National Historical Publications Commission; the rumors of other undertakings great and small now under way or being projected—these and other facts seem to point to promising new fields of professional opportunity. But in contemplating these interesting developments, the prudent young scholar, before he forsakes the heady delights of historiography or of contemporary and “relevant” history, will ask himself whether this is the real thing or only a false dawn. Are these editors the harbingers of a new professional trend, or have they only been struck by lightning?

My own view is that a study of the origin of these enterprises and their somewhat sudden emergence at an illogical moment of history would probably show their dominant causation to have been accidental if not capricious. Despite my earnest probing, I have been unable to discover any great underlying forces that demanded to be

expressed solely in terms of comprehensive editing of documents on a large scale, or any corresponding hunger on the part of the public or the world of scholarship that could be satisfied in this and no other way. The almost complete disappearance of such studies as paleography and diplomatics from the intellectual scene would seem to be evidence in support of my view. So, too, would the opinion of one alarmed historian \* who recently expressed the fear that this matter of treating our American historical documents as if they were Holy Writ or *Hamlet* may be getting out of hand. I am not disposed now, nor have I the time, to argue the point further than to suggest that both Holy Writ and *Hamlet* are better understood today because some of the editorial principles that we are trying to emulate have been employed upon these great texts with results profitable for everyone except dogmatists and doctrinaires.

But, in suggesting that what our distinguished critic has called "an age of great editorial enterprises" may possibly be an age more or less accidentally begun and perhaps not too distantly concluded, I wish to make it perfectly clear that my pessimism rests on a very different foundation from his fears. What I deplore is most certainly not the promised abundance of carefully-edited texts of many kinds in many different areas of our history: it is rather the state of criticism within the historical guild that would view this as a development that might possibly be or soon become an undesirable thing. I deplore the fact that these enterprises, despite the labors of J. Franklin Jameson and others, arose on the edge of the profession, beyond it, or even on occasion, in spite of some obstacles thrown up from within it. This, to me, is the disturbing and sobering aspect of the matter. It is as much this fact as it is my conviction of the importance of this editorial activity that causes me to hope that my skepticism may be ill-grounded and that the end of this "age of great editorial enterprises" may be much more distant than I fear it will be.

I take what consolation I can in the fact that the gift of prophecy, as I have long since discovered, is not among my endowments. As proof of this, I need only point out that in 1939 I read a paper before the Society of American Archivists concerning the immense potentialities being released for scholars everywhere by the microfilm camera and other scientific aids to learning. In the course of my

\* Mr. Frederick B. Tolles, in the January, 1955, issue of *The Pennsylvania Magazine of History and Biography*.

remarks I proved conclusively that multi-volume editions of papers of individuals belonged to the horse and buggy era and would never again have to encumber our library shelves: they would be replaced by vastly enlarged bodies of documentation encompassed in vastly reduced, almost microscopic space, ready to be used anywhere by any scholar. It is no extenuation to say that the lightning which destroyed my prophecy four years later came from the blue.

My false prophecy was a matter of no consequence, but what I overlooked in making it was important. The thing that I failed to take into account was the role of the editor and the function critical editorship performs in the world of the historian. This is a mistake that I was not alone in making, but some years of experience in the critical editing of texts has caused me to realize how grave an error it was and, I regret to add, how far it is still prevalent. The camera is no substitute for the critical editor, and the historical guild will deprive itself of an essential component of its multiform character if it permits its thinking to accept it as such. It is to this point that I wish to address some of my remarks this morning.

The editors in this brave new world do inherit an honorable tradition, even if it is symbolically appropriate that our first prototype in this country bore the name Hazard. Some who followed him in the 19th century had a robustness, an unconventionality, and an occasional fate that we, in our 20th century conformity, do not care to emulate. At least one historical editor became an expatriate; another took up spiritualism; one was shot to death within a mile of this room; another was described by John Quincy Adams as "having no character of his own—penurious and venal—metal [ready] to receive any stamp"; another declared that he would wheel a barrel of apples from Newburyport to Boston if Millard Fillmore failed to carry Massachusetts, a promise which he actually fulfilled in a two-day journey, trundling his apples to the State House with cheering crowds lining the streets; another allowed his historical instincts to triumph over prudence by confirming in his own memoranda the fact that he was born out of wedlock, though it is pleasing to record that this scholarly honesty did not deter him from later occupying the presidency of Harvard.

There are other respects in which our predecessors differed from us. For one thing, they often made handsome profits on their editorial undertakings. Six thousand sets of the first edition of Jefferson's papers were sold immediately on publication and in the South alone. Jared Sparks succeeded in initiating Washington's writings by allow-

ing Chief Justice Marshall one-fourth of his profits for obtaining Bushrod Washington's permission at the cost of another fourth, an arrangement that proved quite profitable to all concerned. Historical editing in those days stemmed usually from the trade of printing and the art of politics, a fact which may account for some of the profits that accrued and some of the lax editorial standards that prevailed.

We may envy our predecessors their solvency, but we do not imitate their editorial practices. We have sharpened our definitions, we have looked at our responsibilities more soberly, and we have different conceptions of our function in the historical guild. We should know what to do with such a letter as that received in 1852 by Henry A. Washington. "My friend Mr. Coles informed me," wrote one James L. Whitney, "that you are preparing Thos Jeffersons Letters for the Press and that there will be many unfit for that purpose, which would be thrown away, and he also said that by writing I might obtain what were not used.—If you should deem it proper would you be so kind as to send to my residence such as you will not use, as they will be of the highest benefit to me in a work on which I am now engaged."

We are no longer content to publish the letters written by an individual while excluding those to which he did or did not reply. We ask a great many more questions of our texts than our predecessors did. We want to know whether a document is genuine, whether it is a received or a file copy, whether its paper, postmarks, or docketing add any essential information. We insist upon collating every text available for those revealing deletions and first thoughts that so often unmask the writer's true feelings or motives. We learn in time to be extremely wary about certain individuals and to question whether James Madison's deletions and corrections were made contemporaneously or were altered in the light of some four decades of hind-sight. We make ourselves responsible for enclosures and other documents that have only a tangential relationship to the texts that we print.

Our eleemosynary enterprises may be less profitable than those of an earlier day, but our range is much more catholic. The impact of new disciplines has rendered obsolete the older preoccupation with literary, political, or military writings, though we try not to slight these still-important categories. Psychologists, anthropologists, numismatists, typographers, paleontologists, linguists, and many other specialists find materials of interest and significance in one of our large-scale enterprises of the present day. This is due partly to the very extent of our canvas, but more to the fact that we have a different

conception of our responsibilities respecting the varied and unforeseeable needs of our constituency. We endeavor to be comprehensive, to be representative, and to keep all matters in scale, for the simple truth is that we do not know enough to be able always to say with certainty what is or may become significant. Even so, we try not to abdicate our responsibility for making decisions and for attempting appraisals.

Not one of our predecessors of the 19th century would have printed or even have calendared the anonymous letter that was signed, no doubt correctly, "A Poor Afflicted Sickly Bruised Reed," imploring Jefferson as president to strive with all his "might and power to get the people to love God and one another." Or that which, with a singular lack of inventiveness, used the terms "Red-headed Rascal," "red-headed villain," and "red-headed son of a bitch" in the course of a twelve-line diatribe addressed to Jefferson. Or the revealing laundry list of 1787, with prices. Or the brief document entitled "A list of reputable Republicans in Connecticut" comprising a total of ten persons—to which Jefferson added one other whose full name he could not recall; and still another, Pierpont Edwards, who he admitted was "originally whig, but a little turned by XYZ."

Such communications form a very small fraction of the great central mass of one president's papers, yet we think it worth noting that this fraction *is* present. One could read all of the previous editions of Washington, Franklin, Adams, Jefferson, and other founding fathers and still be unaware that these poor bruised reeds put pen to paper in their day as in our own, or that the great heroes had laundry problems. We do not intend to magnify the contribution of the psychopathic or the eccentric element, as I am here magnifying it for purposes of illustration, but we do intend to see that it is represented. In other and perhaps more significant respects we also endeavor to be more responsive to a greater variety of needs than were our 19th century prototypes.

One such example in our edition is imposed by the demands of the relatively new and important field of administrative history, though I offer it also as one solution to the vexing problem of handling editorially the great stream of routinized, formal documents that necessarily flows across the desk of any administrative official. During Jefferson's brief two years as governor of Virginia he was required to sign between five and six thousand military and civil commissions, writs, land grants, loan office receipts, licenses, and other documents

expressed in at least sixteen different forms. Such documentation presented no problem to our predecessors: they simply ignored it as trivial or as falling outside any proper definition of history, unless perhaps one of the commissions bore such a name as George Rogers Clark. But we know, or think we do, that legal historians are interested in the development of writs; that administrative historians are interested in forms and procedures; that cultural historians are interested in the spread of printing; and that a biographer cannot properly assess his subject's general behavior unless he knows what stresses and strains he undergoes in the daily round of official chores.

Our solution to this particular problem was to present one or more specimens of each form or writ in facsimile and to describe the history and application of each, including those instances in which war or shortages or some other factor caused routine to be sacrificed. Thus we compressed five or six thousand documents to the compass of thirty-two pages of notes and facsimiles.

I could cite other examples, all tending to show that we interpret our editorial function quite differently from that which prevailed a century ago. I think we have a greater fidelity to accuracy, we take greater pains, we are more precise in our descriptions, we define our chosen corpus and the documents lying within it more exactly, we are freer with our editorial commentary, and we serve the needs of the learned disciplines rather than the cultivated gentlemen who liked to have the editions of the founding fathers on their shelves and were able to pay cash for them.

But out of this new interpretation arises what elsewhere might be called a jurisdictional dispute. Are we editors invading the province of the historian and the biographer—to say nothing of poaching upon the preserves of each other—by our sometimes exuberant editorial comments? Some have said, in effect, leave to others the story of Thomas Johnson's two steers that laid down their lives for the cause of independence and thereby involved the Virginia General Assembly in a turmoil and the editors in long days of research in parliamentary history concerning the nice distinction between a free conference and a full and free conference. Legal historians will trace these things, our critics have suggested, and biographers will set them in proper perspective: your province, as a jealous husband once said to the iceman in a Broadway show, is to deliver ice. But can we editors accept the assurance? Thomas Johnson's two steers helped to lay the groundwork for Jefferson's fruitful studies in parliamentary law, later result-

ing in a famous manual that is still being used by the United States Senate; they also provided his earliest and one of his most vigorous denunciations of the doctrines of Sir William Blackstone; and they indicated that Jefferson was clearly the most powerful leader in an assembly that included some very astute minds. Yet Johnson's steers have plodded their appointed way through the journals of the Virginia Assembly for this century and three quarters without ever having merited the notice of a historian, a biographer, or even, so far as I know, of a genealogist.

Once, in the early stage of our editorial labors, we were more troubled by this question of jurisdiction than we are now. We decided that the proper function of the historian and biographer was to write history and biography, and that the proper function of the editor was to deliver ice. We thereupon adopted the policy of writing articles for historical journals—editors masquerading as scholars, so to speak—setting forth the information that our necessary researches had caused us to accumulate. We would then merely cite the published article when we came to edit the relevant document. It was an admirable solution: it promised to save time, to save space, and to force us to edit our “problem documents” well in advance of our deadlines. We formally announced our plan, and editors of journals were very hospitable. Two or three articles were in fact published, one of them tending to show that the stereotyped view of the authorship of the Declaration of Causes and Necessity for taking up Arms was quite erroneous because historians had relied upon Jefferson's own statements without taking the trouble to compare texts. But practice belied theory. Our plan did not save space, it did not save time, and it made a shambles of our orderly editorial procedures. It was, therefore, allowed to die a quiet and unmourned death. We now write our articles in the form of footnotes, and there we experience some of our most satisfying editorial moments. We attempt compactness, we never search out opportunities for discourse, we leave multitudes of things unexplained, we restrict ourselves to those matters which seem to us important, and we have rarely published any extended comment that was not more or less forced upon us by the necessity of explaining and presenting the text of a document intelligently.

We could have made a simple calendar entry for the brief note from Simon Bérard of 6 May 1786 using only the phrase “request for an appointment.” But we began to ask questions of this document.

Who was Bérard? Why did he request an appointment "before Wednesday," underscoring the adverb? Our three pages of notes set in 8-point Monticello summarize the answers that we found, present a brief biography of one of the leading merchants of France, and hazard the guess that the recourse to the doctrine of natural law to be found in one of the propositions discussed by the Committee on American trade on Wednesday, May 10, *may* have been suggested by one who made use of that pliable concept at various times during his life, most memorably when he wrote the Declaration of Independence. Our guess may be wrong, but it is equally possible that one of the propositions of the American Committee may ultimately prove to be an authentic Jefferson document.

I do plead guilty, but without remorse, to the kindly charge of one critic who felt that we had gone somewhat beyond the call of editorial duty in our total of seven pages of notes on Charles Willamos, an adventurer who captured Jefferson's warm friendship and then mysteriously and with uncharacteristic severity was summarily dismissed. Our plea in avoidance is simply that Willamos fascinated us. So did Mlle. Ladevese, who appears to have got hold of Willamos' copy of *Notes on Virginia* when that unfortunate died a pauper. And so, too, did the search for his will among the 78,000,000 documents in the notarial archives in Paris. We do not know yet whether Willamos, enjoying Jefferson's confidence and living on terms of intimacy with his household, was a British intelligence agent. But we had the pleasure of noting that the cold dismissal took place immediately after the charge was reported to the French ministry.

Are there any who would deny us these innocent pleasures as we deliver our ice? Our indulging them robs no one, and enriches us. The line of demarcation between the areas proper to us and those proper to the historian and biographer is not a straight line, and most of the time it is not a line at all, but a broad indeterminate plain whose arms reach up into the hills whence we draw our strength. There, almost to a man, the historians and biographers have welcomed us and have cheered us on with encouraging words. It is only when those who pursue Clio on the upper slopes fail to read our texts that we are downcast.

## The Papers of Benjamin Franklin

LEONARD W. LABAREE

*Editor of The Papers of Benjamin Franklin*

As Mr. Whitehill has suggested I am here this morning as a neophyte in the fraternity of historical editors. As I sat surrounded by others who have had so many years of experience in this type of work, I wondered why I should speak to you along with them. If there is any justification in my doing so it is perhaps that I can offer some general comment on what it is like to launch upon such a program as we are now beginning, and describe concretely some of the problems which must be faced at the start of such an undertaking.

Mr. Boyd has mentioned many of the ways in which editorial work in the middle of the twentieth century differs from that of the nineteenth. I should add one other difference of major consequence. Editorial work of the sort that we are talking about today has become—in a way which was undreamed of in the nineteenth century—a *cooperative* enterprise. First of all the active editing must be done by a cooperating group or editorial staff. The task is much too big for any one man to undertake. Even such an indefatigable worker as Jared Sparks could not carry through one of these large projects today with the help of only one or two transcribers. It requires a staff of varying but substantial size. Any of these large editions requires the participation of a group of workers, all laboring together in the closest cooperation.

Secondly and in a much larger sense, there is cooperation from a great number of individuals and organizations extending far beyond the personnel of the immediate editorial group. And right here I should like to say that the thing which has struck me most forcefully as we have started our particular work on Franklin has been the remarkable cooperation which we have met in every quarter to which we have gone for assistance. To begin with, the various other editorial enterprises which have preceded us—and several of the most important of which are represented upon this platform this morning—have put at our disposal all their facilities and all their experience. Mr. Julian Boyd and Mr. Wilmarth Lewis represent certainly the finest editorial work which has been going on in this country in our time; both of them have given us every conceivable sort of help. They have responded generously to our appeals for guidance, for friendly advice, and for the

opportunity to tour their operational headquarters (in New Haven such places, unhappily, are called "factories"). Without that sort of help we should have felt lost, and we should certainly have wasted an enormous amount of time.

Then, too, libraries and other institutions, private individuals, autograph collectors and others who have Franklin documents have been most cordial and receptive to our appeals for access to their treasures. And while I should not like to single out any particular individuals, I do want to pay especial tribute to Mr. Philip Hamer of the National Historical Publications Commission, which as a government agency has placed its facilities completely at our disposal and is of enormous help to us and to other similar enterprises. I can assure you from our experience that if some of the other programs which the Commission has recommended in its recent report are carried forward, the prospective editors of those projects can count on having the greatest support and backing from a friendly group in Washington. Cooperation, then, is the keynote of large-scale editing today.

The first problems which confronted a project such as ours were naturally those of organization. Plans for editing an edition of Benjamin Franklin were announced on his birthday in January 1954, and before the month was out my little mailbox in the Yale Post Office was literally stuffed with letters from individuals offering themselves as a part of our organization. These letters made some very interesting reading. In part we were faced with an embarrassment of riches when we found how many people of great ability and high scholarly qualification were interested in our undertaking and available for appointment. Could we have brought them all, or even a number of them, into the enterprise we should have had a most impressive array of editorial workers. That part of our organization, however, had been completed before the project was announced and as a consequence those letters, unhappily, could not lead to staff appointments.

But we had some other very interesting mail, including letters wherein the embarrassment was perhaps not of riches but of something else. Had we accepted the offers of all the former school-teachers, retired Army officers, expert meteorologists, and the like who applied for positions, our staff would certainly not have lacked variety whatever might have been its qualifications for the work actually in hand. The most delightful and the most intriguing possibility that opened up came, complete with photograph in costume, from a gentleman who announced himself as "known from coast to

coast and in ten foreign countries" as the greatest Franklin impersonator. Furthermore, if we should engage him as part of our staff, he wrote, he had great riches to offer. Perhaps the outstanding of these treasures was a photograph, not one of the impersonator, you understand, but a photograph of Benjamin Franklin himself standing beside the Franklin stove! Our joint sponsors, the American Philosophical Society and Yale University, have taken, of course, a great interest in our work and in turn I offered to Dr. Lingelbach, the librarian of the Philosophical Society and to Mr. Babb, the librarian of Yale, these riches if either of them would guarantee the gentleman a post as doorman of his library. Somehow or other neither librarian accepted my suggestion, so the impersonator still walks the streets of Philadelphia in costume.

Once the organization was complete and work formally began, the first great task and the one in which we are now and for some time shall be primarily engaged is the assembling of a photostat file of all Franklin manuscripts which can be located anywhere. The surviving Franklin papers are perhaps more widely distributed and more full of gaps than is the case with most of the others. His manuscripts faced hazards of various sorts. Many of them were destroyed by the British during the Revolution, others disappeared through the carelessness or neglect of heirs, and in some cases his correspondents were all too generous in handing out individual Franklin letters as souvenirs to friends and admirers after the author's death. The problem of recovering these is great but we are undertaking various methods of appealing not only to institutions, large and small, but to private collectors for photostats. The autograph collectors' society, now known as the Manuscript Society, has been most helpful and most cooperative in our work. We are attempting to build up in New Haven, where the editorial headquarters are established, a central file of these photostats.

A brief description of our method might possibly be of interest. We have gratefully taken over and adapted to our own needs some of the devices which Mr. Boyd has suggested to us. The Franklin project is much more like the Jefferson than it is like any of the other great enterprises now going on, so that his methods have proved most useful to us. With some adaptations that we found desirable we have followed his pattern and gladly acknowledge his leadership.

When a group of photostats comes in from a particular library or private owner these are assigned numbers in a single general sequence. The number of each document is stamped on the back of each page

of photostat and is carried with that document throughout its career in the editorial office. The documents in the group are then recorded by number in a source file indicating the library or individual from whom they came. The photostats are then sent through a sort of assembly line (perhaps the term "factory" is justified, after all). In the course of this procedure the documents are checked against previously published editions of Franklin's works to see if they appeared there or not. For each a file slip is prepared in triplicate, showing the date of the item, the names of the writer and the recipient, and other pertinent information. One of these slips is filed chronologically, the second alphabetically by the name of Franklin's correspondent, and the third numerically according to the accession number originally assigned. A preliminary reading of the text provides slips for a rough subject index. With the source file, the chronological, alphabetical, numerical, and subject files we believe that we have sufficient controls so that we can locate information and turn up any particular document with relative speed.

Meanwhile large manila envelopes have been prepared to hold the photostats, each marked conspicuously with the date of the document and its title or the names of the correspondents (whichever is required) and these are shelved in a single chronological sequence. In the course of our work, whether during the process just described or later, any bit of pertinent information about a given document which comes to hand is simply written on a piece of paper and dropped into the envelope with the photostat. When we reach the stage of actual editorial work—still unhappily far ahead of us—everything we have accumulated about that document will be right there with the photostat. This device eliminates the need for an elaborate system of note files, with cross files and references which, with such a large body of documentary material, would be cumbersome at best and might easily allow us to overlook some important item of information when we most need it.

The work involved in these procedures is obviously considerable, but it progresses with satisfactory speed. During the first six months of operation two or three people working full time and three or four others, including undergraduate assistants, on a part-time basis, have processed, indexed, and filed about five thousand individual documents, and now that we have gained experience we can handle well over a thousand documents a month. At this rate our photostat file should be substantially complete in two years from the start—pro-

vided, of course, that in that time we can locate the documents and secure the necessary photocopies.

While all this has been going on, we have been spending as much time as we could upon basic problems of editorial policy. During the summer the assistant editor, Mr. Bell, and I had long daily conferences, often lasting far, far into the night, and then after discussion with the Editorial Advisory Committee, which met in September, we were able to lay before the Administrative Board our major plans. I may state here very briefly what these are, but it should be borne in mind that these are plans only, and not fulfillment. The edition will probably run to twenty-five or so volumes and will be arranged in a single chronological sequence. Suggestions that we arrange the material topically or by correspondences simply would not work out satisfactorily in the case of the Franklin papers. We plan to publish the entire correspondence, both from and to Franklin, except that in some instances—Mr. Boyd has alluded to this general problem—we shall print some letters to Franklin in abstract only. To give a single example: When Franklin went to Paris as American representative he was at once swamped with hundreds of letters by Frenchmen and other Continentals asking for commissions in the American Army. Many of these letters undertake to state the qualifications of their writers; often these were microscopic, sometimes consisting simply in the fact that the writer had seven dependent children to feed. Always the letters were written in grandiloquent French or in curious half-broken English; always the writer proclaimed his passionate devotion to the American cause and to *la liberté*. Franklin and the American Army were plagued throughout the war by these applicants. So far as the records show he never answered a large proportion of these letters; he would not have had the time. It seems unwise for us to try to print each one of these in full. We shall print representative samples and certainly all those from men who did ultimately play a significant part in military or other affairs. The rest we shall give in abstract only, printing all names, including them fully in the index and indicating the locations of the manuscript originals, so that anyone who does have occasion to look up their writers may find the essential information in our volumes. With such exceptions as these and with the further exception of purely routine documents signed by Franklin, such as bills of exchange, money warrants, bankruptcy commissions and the like, we plan to make this edition as comprehensive as the success of our search for surviving papers makes possible. Lastly, I may add

that we plan to include an index in each volume and one or more cumulative indexes at the end of the entire series.

In conclusion, I return to the point with which I began. This project is cooperative, as all such undertakings must be. Just this morning Mr. Thomas Copeland, editor of *The Papers of Edmund Burke*, handed me a file of photostats of letters exchanged between Burke and Franklin which have turned up among the Burke papers in Sheffield, England. This sort of cooperation, repeated again and again, meets us on every hand. The cordiality, the friendliness, and the close relationships constantly building up, not only among members of the little fraternity of editors, but with the larger world of scholars, librarians, and collectors everywhere, have given us in the Franklin group our most heart-warming experience in these first short months. It is indeed one of the great joys to be discovered by all those engaged in editing the papers of great men.

## The Adams Papers

L. H. BUTTERFIELD

*Editor-in-Chief of The Adams Papers*

I AM so junior a member of this editorial fraternity that I feel real diffidence about speaking in the presence of my elders and betters. And as for talking to the scholarly public on the topic of *The Adams Papers*, I feel even greater reluctance, since I can say little about the enterprise I have just taken up that is not extremely tentative, not subject to revision or even reversal next week or next month, depending on the discoveries that are being made almost daily in the archives of the Adams family.

Dr. Johnson said of certain philosophical passages in the *Essay on Man* that in writing them Mr. Pope had been "in haste to teach what he had not learned." I may well be charged with the same fault. But there is another literary reference that I have lately felt the force of, too. Keats in his sonnet on Chapman's Homer pictures "stout Cortez" and his companions on a peak in Darien looking at one another "with a wild surmise." The phrase is splendidly applicable to one just beginning the exploration of the Adams manuscripts as they stand in serried rows of leather bindings differently colored for the several generations, or spill from boxes, bundles, cases, drawers, portfolios, and every

other sort of receptacle, including packets of papers that are tied up in other manuscripts. (Parchment laws and commissions, being over-size and durable, make handy wrappings; and being plentiful among this family's papers, they were sometimes used for this purpose.) It will be impossible to tell for some months to come with any reasonable accuracy just what is going to be found in this immense accumulation of the records of a peculiarly record-keeping family over a period of more than two centuries. A brown-paper parcel may contain several hundred retained copies of Abigail Adams' letters written throughout her lifetime and evidently not examined during the last half-century. Next to it may stand a ledger of kitchen accounts kept by John Quincy Adams' cook in St. Petersburg. A box stuffed with loose papers with Henry Adams' name affixed to it yields long sequences of letters from Mrs. Henry Adams to her father in the 1870's and 80's—the very sequences, a quick check shows, that were supposed lost when a volume of Mrs. Adams' letters was published in 1936. These discoveries are interestingly amplified by further contributions from living members of the family, who are now ransacking their desks and cupboards, and from friends and even perfect strangers, who have been sending in stray Adams letters and papers by ordinary mail. (One Christmas card brought two Adams letters of different generations attached to it.)

These are in part the fruits of publicity that has been so extensive and favorable that one of the editor's most serious worries is how he will manage to live up to the announcements of the coming attraction. But at least the public accounts have set forth the details of the administrative, financial, and publishing arrangements so fully that it is not necessary to repeat them here.<sup>1</sup> In summary they call for publication on three levels:

1. A microfilm edition of the entire contents of the family archive. This project is being self-financed by subscriptions from research libraries throughout the country. The film edition is unrestrictedly free for research purposes, but it is copyrighted and the literary rights remain with the Adams Manuscript Trust. Per-

<sup>1</sup> In addition to the news stories of 15 October 1954, and an illustrated article in *Life*, 25 October, see the authoritative article, "The Adams Papers: The Records of Two Centuries of a Harvard Family," by Walter Muir Whitehill, in the *Harvard Alumni Bulletin*, 23 October 1954. The organizing genius of Mr. Whitehill, Director and Librarian of the Boston Athenæum, underlies the whole enterprise.

mission must therefore be obtained (on forms provided) to quote from the films for publication in print.

2. A series, or rather several series, of volumes, the number as yet unpredictable, to be issued in letterpress by Harvard University Press over its new Belknap Press imprint, for general sale.

3. Serial publication in *Life*, which is meeting the editorial costs of the enterprise, of such portions of the papers as appear to have very wide public interest.

These plans, worked out during the last couple of years among the Adams Manuscript Trust (the present owner), the Massachusetts Historical Society (the sponsor of the edition and eventually to be the owner of the papers), the Harvard University Press, and Time, Inc., present a unique challenge to the editor and his staff. The family's gift is incomparable. Its value on the autograph market would run to an astronomical figure, but there has been at no time any thought that the donors should receive any pecuniary return or that they should exercise editorial surveillance or veto-power. This generosity and trustfulness make the editor's responsibility all the graver. He may well feel, as he does, both proud and humble in assuming it. At the same time he is deeply grateful to *Life*, whose editors were willing to back up with a large sum of money their conviction that Americans are sufficiently interested in their own past to read the records that document it. This was a courageous decision, and the editor of The Adams Papers is naturally eager to prove it a sound one. Seldom has an historical scholar been given the opportunity to place even portions of his work before so large an audience.

The Adams Papers consist of an estimated 300,000 pages of material in the form of diaries, letterbooks, incoming letters, political, diplomatic, and literary writings, and an indescribably diverse miscellany of account books, commonplace books, legal and business papers, genealogical and historical notes, commissions and diplomas, sketches and drawings, maps, pamphlets, broadsides, posters, passports, cipher keys, newspaper clippings, and even check stubs. The earliest papers date from the 1630's and the latest from about 1920, but the greatest concentration is in the period from about 1755 until the 1880's, spanning the active lives of the three generations of Adams statesmen—John, John Quincy, and Charles Francis. After examining the family archives created and accumulated up to 1888, Edward Everett Hale said that probably nowhere else in the world could "the history of a

great nation . . . be so studied in the [records] of one family." This judgment still holds and is in fact reinforced by the addition to the collection of important segments of the papers of Charles Francis' gifted sons, the last of whom, Brooks Adams, lived until 1927.

At Quincy on 20 July 1834, John Quincy Adams noted in his Diary:

Copied into my letter-book the letter written last evening to my wife. This is noisome and to me useless labor, consuming time which might be fruitfully employed. But in my father's first letter-book I find him saying, on the 2d of June, 1776, that in all the correspondence he had maintained, during a course of twenty years at least that he had been a writer of letters, he never kept a single copy; and, he adds, this negligence and inaccuracy has been a great misfortune to him on many occasions. A letter-book, a diary, a book of receipts and expenses — these three books, kept without intermission, should be the rule of duty of every man who can read and write. But to keep them perseveringly requires a character given to very few of the sons of men. Above all, it requires a character to which toil is a pleasure, and of which untiring patience is an essential element.

Well, this was the kind of character that the Adamses had, though there were deviations from the most typical of them, John Quincy Adams. Even he had occasional lapses in his record-keeping habits, for which he usually atoned by devoting a page or two to self-reproaches after he had missed a day or more in his diary.

To explain in any adequate way this hereditary compulsion to create and preserve records would require an essay in itself. Its root cause, I suppose, was the family's passionate determination to make permanent contributions to the improvement of their country and their kind, an urge symbolized by John Quincy Adams' tireless tree-planting activities and his acorn and oak-leaf seal with its motto "*Alteri Seculo.*" In the context of the Adamses' intellectual, moral, and patriotic mission, everything they said, thought, and did took on significance and accordingly had to be set down in permanent form, even to the toasts exchanged at a Fourth of July celebration of the Newburyport Fire Department in 1837. (John Quincy Adams' toast was: "The Fire Department of Newburyport—always prepared for duty, may they never be needed to perform it!") Accordingly, too, they were vigilant custodians of the records of Adamses of previous generations. John Quincy himself was too steadily occupied with public duties to spend much time on what he called "stale political excitements," but his son Charles Francis enjoyed the role of family archivist and editor and discharged these tasks in the intervals of his public service much

more competently than most family historians of his time did. After Charles Francis' death his son Henry spent some time and thought on the proper disposition of the papers, but his interest was brief, and it fell to Henry's older brother, another Charles Francis, to assume this important responsibility. Following his spectacular business career, the second Charles Francis grew more and more absorbed in the family archives. He used them himself here and there in his innumerable books and essays, and he planned and worked many years on a proper memorial to his father, somewhat analogous to the great edition of John Quincy Adams' *Memoirs* that the first Charles Francis had prepared. It was the second Charles Francis, evidently, who conceived the typically Bostonian idea of a trust, to which all the descendants of the three Adams statesmen would relinquish their right of ownership, as the custodian of the family papers. This sensible plan was carried out in 1905, and the papers were moved from the Stone Library on the grounds of the Old House at Quincy to a locked room in the new building of the Massachusetts Historical Society. Soon afterwards Mr. Adams engaged Worthington C. Ford to serve the family as well as the Society as editor and thus to exploit such parts of the papers as Adams himself was not working with. Over the years that followed, Ford published a number of volumes of rather arbitrarily selected materials relating to all four generations. In the meantime Charles Francis Adams' plans for a documentary account of his father's diplomatic career grew more and more elaborate and then collapsed under their own weight upon his death in 1915. Thereafter, access to the papers became steadily more restricted until by the 1930's they were closed to the public, to the members and staff of the Society, and virtually to members of the Adams family who were not trustees.

Whatever may be thought of the past policy of the Trust, it kept the papers intact, and the reversal of that policy by new and younger trustees has now created an extraordinary opportunity to plan a large-scale edition of the papers of a family whose members have been leaders in American political and intellectual life from before our existence as a nation down to our own time.

There are basic likenesses, of course, between The Adams Papers as an editorial project and the other comprehensive scholarly editions of historical documents now in progress. The imagination and skill of Julian P. Boyd, under whom I was fortunate enough to serve as an

apprentice on *The Papers of Thomas Jefferson*, have put those who are following in his footsteps heavily in his debt. His pioneering methods of organizing and presenting great masses of historical documentation are well known to everyone who has studied the *Jefferson* volumes closely. Much of what I learned at Princeton and also on visits to the Horace Walpole and Benjamin Franklin "factories" at Yale, I shall be able to apply to the work on the Adamses in Boston. But the present audience will doubtless be more interested in the differences in policies and procedures that are necessarily—and I again remind you, tentatively—being worked out in the office of The Adams Papers in the Massachusetts Historical Society.

These differences result from the unique conditions the editor finds himself faced with. The Adams Papers have never been out of family hands, and though they have had loving care it has been of an amateur kind. The strictly curatorial problems facing The Adams Papers staff are therefore considerable. We are obviously going to be concerned for some time to come with putting the papers into usable form. This means extensive repair work and measures for permanent preservation as well as establishing editorial controls. For a good while and perhaps all the way through, we shall be less concerned about Adams documents in outlying repositories than we shall be with organizing and refining the materials in our own front dooryard. This is not to say that we are indifferent to pertinent material outside the family archives, and we do most decidedly want to be informed about it, but from the necessity of things we cannot afford the time or money to conduct the intensive searches that have become the rule in such enterprises. To be meaningful, our searches would have to be on a much larger scale, since we would be attempting to gather in not the correspondence of one man but of at least a dozen or so Adams men and women over a century and a half. One shrinks from the thought of the cost and effort a really exhaustive search would require.<sup>2</sup>

The very long time-span and the great physical bulk of the records impose another condition on the editor. He is going to have to be

<sup>2</sup>Major groups of Adams papers in archives and manuscript collections outside the family holdings will, of course, be listed for our files and drawn on in the editorial process. Thus, for example, by agreement with the National Historical Publications Commission, which has recently played so active and benevolent a role in promoting the publication of historical papers, microfilm copies of the holdings of Adams papers in the National Archives and the Library of Congress will be furnished to the Adams enterprise.

selective in printing these records. It would be perfectly chimerical to assume that everything that all the Adamses—or even any single Adams—wrote is worthy of preservation in print. Many of them wrote *too much*. A chronological file of their published books and pamphlets alone (including revised editions) runs to nearly 500 entries, which makes an average of two-and-a-half Adams publications a year over the past two centuries. To republish all of these productions from the manuscripts, where the drafts of most of them remain, would result in a work rivaling Migne's *Patrologia Latina* in bulk and doubtless in tiresomeness. The Adams Papers will therefore not be as inclusive as either the Jefferson or the Franklin editions now in progress, but the editor's conscience is little troubled by this decision, since the complete corpus of manuscript material will be available to researchers on film. In some respects it is more difficult to follow a selective policy than an all-inclusive one, since decisions about specific papers have constantly to be made. But selectivity can also ease the editor's task by allowing him to sidestep problems that would require more time and space to work out than he believes he can afford. For better or worse, one result of our policy will be that many of the riddles and knotty problems relating to the careers of the Adamses will be left for solution to scholars not on the editorial staff.

A final and very marked difference between the Adams enterprise and others now in progress is that, since The Adams Papers will document the activities of a whole family over several generations, rather than of a single central figure from youth to death, the order of presenting the records will be more complex. A working plan, which will doubtless have to be greatly refined, envisions four sequences of volumes as follows.

First, the great diaries of the three Adams statesmen, John, John Quincy, and Charles Francis, which extend, with large overlaps, from 1755 to 1881. The diaries will be printed complete, if only because the greater portions of both John's and John Quincy's were published in the 19th century, and another selective edition of either simply could not be justified. It is not possible to indicate in a brief space what will be "new" in the unpublished portions of these two diaries. In the case of John Adams' it will be principally numerous small details. In that of his son, there will be a very great deal of new matter on his personal and domestic life; we shall know John Quincy Adams much better when all this evidence is in. Charles Francis Adams' diary is almost wholly unpublished. Kept for over sixty years, 1820-1881,

it is only less extensive than his father's gigantic personal record, and it is a pricelessly thorough and wonderfully readable record of, among other things, the antecedents and early years of the Republican Party and the diplomacy of the Civil War and its aftermath.

Second in line will be the Adams family correspondence, stretching in an unbroken sequence from the courtship letters of John and Abigail in the early 1760's to the multiple-sided correspondence of Charles Francis Adams and his sons during and after the Civil War. The most distinctive feature of the collection of manuscripts known as The Adams Papers may well prove to be this constantly changing but continuous record of family activities, reflections, and chat over four generations. Correspondents are from time to time withdrawn by death, but they have already been replaced by others, and the record swells rather than diminishes from decade to decade. The sons in each new generation, strategically placed in some vantage-point of observation in Europe or the United States and schooled by family example and tradition to be observers, start their numbered series of "dispatches" to grandparents, parents, brothers, and sisters at an incredibly early age; and, as the family habit was to preserve every scrap of writing, the resulting record is incomparably full. In editing John Adams' *Works* in the 1850's, Charles Francis Adams adhered to 19th-century standards of editorial propriety by largely excluding personal letters from volumes memorializing the public career of one of the founders of the republic. He did so, however, with reluctance; and he supplied the omissions to some extent by publishing several select collections of his grandparents' private correspondence. This he realized was a "novel" thing to do, but he justified it on the ground that we must know the *inner* lives of historical personages if we are fully to understand history:

Statesmen and generals rarely say all they think or feel. The consequence is, that, in the papers which come from them, they are made to assume a uniform of grave hue, which, though it doubtless exalts the opinion entertained of their perfections, somewhat diminishes the interest with which later generations study their character. . . . We look for the workings of the heart, when those of the head alone are presented to us.<sup>3</sup>

The family correspondence of the Adamses is rich in material revealing "the workings of the heart," not only for the first generation prominent in public life, but through several following generations

<sup>3</sup>*Letters of Mrs. Adams, the Wife of John Adams* (2d ed., Boston, 1840), I, xiv-xv.

that observed and participated significantly in the development of the nation. Moreover, it will furnish to the social historian, whether or not he is interested in the Adamses as individuals, abundant evidence on how our ancestors dressed, ate, traveled, studied, philosophized, worshiped, cared for themselves when sick, quarreled and made up, loved, married, and died.

The third category will be the general, or non-family, correspondence of the major Adamses, which will group itself naturally into three subdivisions around the three Adams statesmen. Both outgoing and incoming letters will be considered for inclusion on the basis of their interest and importance, but, like the family correspondence, this sequence of volumes will necessarily be selective. How inclusive of similar and related materials like diplomatic dispatches, state papers, and executive messages this series will or can be, is a point not yet determined.

A fourth category of papers will be left that might almost take its name from one of John Quincy Adams' pocket memorandum books that he called "The Chaos." At present it is entirely uncertain how the remainder of the collection should be handled editorially, though clearly the bulk of the political and literary writings (addresses, tracts, newspaper contributions, poems, translations, and the like) will be adequately preserved on microfilm. In the editing of the several preceding series, this body of material will be drawn on for elucidation when desirable, but its disposition will not be settled until after the diaries and correspondence have been taken care of. The exhaustion of the editorial funds before this point is reached may possibly, and perhaps mercifully, relieve the editor of this final, difficult responsibility.

It is not for a scholar to assess the long-range value of his own work. To conclude this paper I am therefore resorting again to some observations made by a remarkably skilful and honest editor of the last century on the importance of documentary publication. They apply equally well to all the large-scale editorial enterprises in the historical field that are now current. In pleading for faithful transcripts of the records of the founding fathers' lives, both public and private, Charles Francis Adams wrote in 1841:

We are beginning to forget that the patriots of former days were men like ourselves, acting and acted upon like the present race, and we are almost irresistibly led to ascribe to them in our imaginations certain gigantic proportions and superhuman qualities, without reflecting that this

at once robs their characters of consistency and their virtues of all merit. It is imitating the conduct of those poets and romancers who laud their heroes for courage after having first made them invulnerable. Fancy may do what it pleases as its purpose is only to amuse, but history has a nobler object. The veneration which attaches to great men should not be barren of all emulation in those who feel it. The present race of Americans may not be called to make precisely the same exertions in the field that were made by their predecessors, but it will be subjected to internal struggles perhaps even more violent than theirs. Struggles, success in which makes the glory that distinguishes the patriot from the demagogue, and the attaining a victory in which renders the path of rectitude and of honor equally hard to tread in every age and under every clime.<sup>4</sup>

This is no sentimental plea. Our heritage in the form of historical records is a rich one. It is at least as important a part of our national resources as, for example, our mineral wealth or our industrial installations. Over several generations members of the Adams family exhibited self-sacrificing devotion to the public interest, rare qualities of intellectual leadership, and unflinching moral courage, to set a record of accomplishment and aspiration unequaled by any other family in our own history, if in any. That record is certainly one of the noblest products made in America, and just as certainly the billions of dollars being poured into research on atomic energy and jet-propulsion cannot provide an equivalent. We can, however, spread the record before the world, to be read, understood, and, in some degree, emulated.

## Editing Familiar Letters

WILMARTH S. LEWIS

*Editor of The Yale Edition of Horace Walpole's Correspondence*

A NEIGHBOUR of mine has been planning an edition of her late brother-in-law's letters. He was the author of three or four delightful books; for forty years he wrote his family and friends amusing letters from all over the world. Everyone who has seen them agrees that they make an entertaining footnote to the history of their time.

My friend's initial enthusiasm for her undertaking has cooled somewhat. She has the letters her brother-in-law wrote to her husband,

<sup>4</sup>*Letters of John Adams, Addressed to His Wife* (Boston, 1841), I, xiii-xiv.

to his mother, and to herself, but she can't find any of his other letters. The recipients of them have died; their families are full of promises that they do not carry out. It begins to look as if she is not going to get these other letters and that her edition will be incomplete. Furthermore, she is now having trouble finding the letters that she has. She reads to friends pages from them that illustrate the engaging qualities of her brother-in-law's mind and the complexities of her editorial problems, and these pages have a way of getting mixed up with the tea things and of being later put away by an irresponsible maid with more concern for neatness than for footnoting history. Since the date of the letter is not on the sequestered page, the labours of identification have mounted; but no doubt it will all come right in the end. Meanwhile, here is a page in which Fred said exactly what he thought of a brilliant and beautiful cousin, a lady still very much alive, with children and grandchildren, *and* a husband. Can the passage be printed? And what about this Rabelaisian bit of considerable explicitness? Again, here is a passage that suggests a certain waywardness. Fred, she assures her listener, was not that sort of person at all; should she suppress the passage? Other paragraphs are just plain dull, and she has crossed them out in ink. Since these deleted paragraphs make the letters in which they occur too short, she has spliced to them certain other letters written about the same time and from the same place. It must be confessed that the work has bogged down. The niceties of editing, the dozens of questions having to do with arrangement and style, of indexes and "method," have not as yet been considered; indeed, they have not as yet been imagined.

My friend's approach to the problem of editing familiar letters is similar to that of countless other editors before her. That is the way Mrs. Piozzi went about editing the letters of Dr. Johnson, Mason Gray's, and Miss Berry Horace Walpole's. It has been only in comparatively recent times that the editing of letters has been taken seriously, which is strange because the historical importance of letters has long been recognized. "Nothing," Walpole wrote, "gives so just an idea of an age as genuine letters; nay, history waits for its last seal from them." It is the editor's duty to make this seal intelligible to "history," but the difficulties in his way are many. Among these difficulties I select two: the problem of finding the original letters and the problem of annotating them.

The editor must get back to the original letters if he can, not only to those that are unpublished, but to the letters that have been printed,

because the methods of my friend and neighbour have been the rule rather than the exception: until you see the manuscripts you cannot be certain that you are editing what your author wrote.

At the outset, the editor probably knows where a certain number of the manuscripts are because of his predecessors' and his own researches. Let us assume that in the beginning he knows where 20 per cent of them are; he suspects that many more have been destroyed, not only by the recipients of the letters, but by the man's family. The surviving letters may be scattered about the world. How does he find them?

They are in three places: in bookshops, in libraries, and in private hands.

The first of these sources, the booksellers, is the easiest of access. The more valuable the letters are commercially, the more apt they are to be in the few bookshops that stock expensive manuscripts. The editor should of course establish pleasant relations with these booksellers and with the auctioneers through whose hands pass a large proportion of the letters that reach the open market. He should go further and cultivate the friendship of all who visit country houses for purposes of probate; he must not shrink from the character of ghoul.

The second source, public libraries, is not as accessible as it might at first appear to be. When I began the *Yale Walpole* twenty years ago I sent a circular letter to 800 librarians around the world requesting photostats of letters to and from Walpole in their possession. I was disappointed when only eight out of the 800 replied and when only one, the National Library of Victoria, at Melbourne, had an unrecorded letter; but I was lucky to get that, I now realize, because librarians have a natural distaste for persons who ask librarians to do their work for them. Since then I have found—and friends have found for me—several hundred letters to and from Walpole in libraries in Britain and America.

The third place where letters are kept, the private library, is usually the most difficult to discover, and when discovered it may test all the editor's skill as a diplomat. Private collections can be divided into those that have been recently collected and those that have been inherited. If the letters have been collected by a person still alive the collector may be well known in the book world; he may even write voluntarily to the editor to offer him the letters for his use. He may, on the other hand, refuse to let the editor use them or even see them,

but such churlishness is far rarer than it is sometimes supposed to be. If the letters have been inherited it is quite possible that their owners do not know that they own them.

Collectors of letters live all over the world. I have found letters to and from Horace Walpole as far away from Twickenham as Dunedin, Honolulu, and Lima. For all I know, there may be letters to and from him in Darjeeling and Butte, Montana; more probably, of course, there are some in Shropshire or County Wicklow. The letters that are slumbering in a country house, perhaps unknown even to their owners, are the letters that furnish most of the collectors' stories. How does one find them? Many methods are used: will-searching, letters of appeal in weekly journals, articles in magazines, lectures, broadcasts. By these methods I have discovered about a dozen letters. By searching auction sales catalogues and by advertising in newspapers I have found perhaps 2,000.

The problems of annotation are legion, but they become less formidable if the editor keeps in mind one question, "What is best for the reader?" The presence of the editor's readers must always be before him. They are, presumably, persons like himself, and he may assume that they share with him certain knowledge. It is when he proceeds to the less familiar that he begins to wonder what he should annotate and what he may pass over in silence. He will find comfort in what Dr. Johnson said on this subject. "It is impossible," said Dr. Johnson, "for an expositor not to write too little for some, and too much for others. He can only judge what is necessary by his own experience; and how long soever he may deliberate, will at last explain many lines which the learned will think impossible to be mistaken, and omit many for which the ignorant will want his help. These are censures merely relative, and must be quietly endured."

There are times when the best course is to do nothing. When Walpole writes from Paris that the French had become very simple in their dress and equipages, that the English were living upon their old gods and goddesses, and that "I roll about Paris in a chariot decorated with cupids and look like the grandfather of Adonis," we did not intrude with a note on Adonis or his grandfather. Nor do I think comment is needed on this passage in a letter to Lady Ossory: "When by the aid of some historic vision and local circumstance I can romance myself into pleasure, I know nothing transports me so much. . . . I sometimes dream one day or other somebody will stroll about poor Strawberry and talk of Lady Ossory—but alas! I am no

poet, and my castle is paper, and my castle and my attachments and I shall soon vanish and be forgotten together! " It would be a disservice to the reader to point out that Walpole was the author of 3642 lines of verse, that instead of vanishing soon he lived nineteen years, six months and sixteen days longer, and that Strawberry is still standing, in spite of the encroachments of Greater London and the effects of a German bomb on the night of 15 December 1941.

The editor must be on his guard against ostentatious pedantry. He must not inflict upon the reader all the steps he took to solve a knotty problem, the learned works he consulted, which were of no use to him, and so on, great as the temptation may be to show his ingenuity, his mastery of libraries, his patience, and his indomitable will. The reader is interested only in the solution of the problem, which should be stated in the fewest syllables that will give it clearly. Another annoying form of pedantry is to refer to rare and inaccessible editions of works that exist in readily available editions. It may be advisable to refer to the edition that his author read, but if that is a rare book and there is a modern reprint of it, the editor, I think, should also give a reference to the modern edition. And when a reference is made to a fact that is in many books it is absurd to send the reader to an edition printed in Oslo or Budapest when the London or New York edition will serve better. The ease with which the reader uses the work and his satisfaction with what he finds in it are measures of its success. The editor must resist the temptation to invent ingenious devices in presenting his notes and index; he must not, on any account, be clever. His referenceness should be made in as lucid and concise a manner as possible, but they should not be so condensed that the reader cannot understand them; the edition should not be turned into a private language that is intelligible only to those who have undergone a prolonged initiation in it. "Lucidity, simplicity, system," those words of Sir Henry Maine describe the essence of good editing. Clear presentation the editor should be able to provide; satisfaction is something he must pray he will be able to give.

It is when the editor goes beyond routine obligation and tries to give an enrichment of the text that he advances to something still more difficult—and a more rewarding part of his work. To be able to produce contemporary evidence that proves or disproves his author's statements is a legitimate triumph. This evidence is to be found in government reports, trials, prints, newspapers, magazines, and in many other places, particularly in unpublished manuscripts. It is a pleasure to find

this evidence in statements that his author and his friends have made in their letters or diaries or in the margins of their books, which they have later forgotten. To take a small example, Walpole bought Conyers Middleton's collection of classical antiquities. William Cole noted in his copy of the *Description of Strawberry Hill* that Middleton complained of Walpole's having paid him only £20 for it. Left at that, Walpole appears as a rich young man who took advantage of an impecunious old scholar to whom he owed much. But at Farmington, in one of his own copies of the *Description of Strawberry Hill* Walpole noted that he paid £125 for Middleton's collection. This would seem to settle the matter, but for the fact that also at Farmington is the receipt for the transaction, signed by both parties, and it proves that Walpole gave Middleton not £20, not £125, but £131. Producing such proof whenever he can find it is certainly part of an editor's job. It is easier to produce it than to reach the ultimate goal.

This unattainable goal is for the editor to become so familiar with his material that he will be, as it were, inside the writer and recipient of the letters when they were written and read. Editors of Walpole, for example, must try to place themselves in his chair as he sat late at night in the library at Strawberry Hill writing to such very dissimilar people as Lady Ossory and Cole. Apart from its 4,000 books we would find the library bleak, the candlelight insufficient, the use of a quill irritating, but these things appeared otherwise to Walpole. Before him was a stock of well-sharpened quills, the light he wrote by was the best that could be procured, and as for the 'bleakness' of the room, how could a room be bleak that had a ceiling with one's arms painted on it by Clermont, the clock given by Henry the 8th to Anne Boleyn, and seven ossuaria? We must try to see these objects as Walpole saw them. More important, we must try to see his correspondents as he saw them, to be aware of the subjects he avoided with them, while remembering his own prejudices and enthusiasms, his age at the time of writing, the state of his health and his temper, what was uppermost in his mind at the moment, and whether or not he felt that posterity was looking over his shoulder.

We have certain advantages that he and his friends lacked: we know what was to happen to them, the pleasures and disappointments that were in store for them, and when and how they were to die. But we cannot enter completely into their lives because each generation differs from its predecessor and we are on fairly sure ground only with our own. Years spent upon the study of a former age will help

to overcome this handicap; the devoted and imaginative student will gradually accumulate a considerable store of information about it; he will discover and absorb many of the tacit assumptions of the time that his author's correspondents took for granted; but he will not know all of them; and he will never be able to divest his mind of all that they never knew. We may think we can picture a world without anaesthetics, a world in which duelling was not uncommon, where paupers' graves were left open for weeks, and highwaymen were hanged in chains in the public way, but if we were magically conveyed back to the eighteenth century there would doubtless be a thousand circumstances that would come to us as a shock. Our ignorance of them prevents us from entering into the daily lives of people of that time; but certain things do not change, and, you will forgive the truism, human nature is one of them. It is possible by long and sympathetic study for the editor to know his author better than the author knew himself. The judicious use of this knowledge, which at times may come in a flash of insight, will illuminate much that without it would be dark. Here, perhaps, is where the editor can make his greatest contribution. It is, at any rate, the one, I think, that gives him his greatest satisfaction.

## Remarks

WALDO G. LELAND

*Director-Emeritus, American Council of Learned Sciences*

THE brilliant papers, so full of literary charm, to which we have listened with obvious appreciation and pleasure seem to call for a brief historical footnote to underscore their appropriateness in a session of the American Historical Association.

I recall that in 1907, John Franklin Jameson, president that year of the Association, proposed that the latter should set up a Committee on Documentary Publications of the Federal Government. It will be remembered that it was Jameson who had brought about in 1896 the creation of the Association's Historical Manuscripts Commission, of which he was for several years the chairman and for which he edited a stout volume of the papers of John C. Calhoun printed as Vol. II of the Association's *Annual Report for 1899*. (For those were the happy days when our *Annual Report* came from the Government Printing

Office to be distributed generously and widely, in two or more substantial volumes, which sometimes aggregated as much as 1000 pages.) Also it had been Jameson who had proposed to the Carnegie Institution, as a member of its Advisory Committee on History, in 1902, along with a large program of essential historical activities, the preparation of *Guides to the Archives of the Federal Government in Washington*, which became the first historical project of the new Institution, and indeed one of its first projects of any sort. The second edition of this *Guide*, which I had just revised, was published in 1907, and the creation of the Committee proposed by Jameson was a logical sequence. By that time Jameson had been for two years Director of the Carnegie Institution's Department of Historical Research and had addressed himself with accustomed vigor and resourcefulness to the most pressing archival problems of the national government.

The Committee was duly created by the Association, its members being, along with Worthington C. Ford, chief of the Division of Manuscripts of the Library of Congress, who served as chairman, and Jameson, who served as secretary, Charles Francis Adams, Charles M. Andrews, William A. Dunning, Albert Bushnell Hart, Andrew C. McLaughlin, Alfred T. Mahan, and Frederic Jackson Turner. Discussions between Jameson, Herbert Putnam, Librarian of Congress, and President Theodore Roosevelt resulted in the Association's entire Committee being incorporated in the "Committee on Department Methods," as one of its "Assistant Committees." This gave the Committee official status and financial support, and assured the presentation of its recommendations to the President of the United States and eventually to the Congress.

The report of the Committee, which was put in final form by Jameson, was presented to President Roosevelt in January, 1909, in a personal interview. I recall that Jameson told me that Charles Francis Adams, in his usual blunt manner, announced to the President that the Committee came with recommendations which would cost the Government vast sums of money. Jameson felt that this was not the most fortunate approach from the "Assistant Committee" of a Committee which had been set up in the interests of efficiency and economy in the conduct of the Government's business.

The major recommendation of the "Assistant Committee" was for the creation by Congress of a Commission on National Historical Publications, and was accompanied by a draft of a Bill for that purpose. The President submitted the report to Congress, the Bill

was introduced and at least one hearing was held, which resulted in some amendments, but the Bill never came to a vote. With Scotch-Irish persistence Jameson was diligent to keep the matter from being forgotten, but the still more vital problems of preserving the national archives and of assuring their efficient administration took precedence in his thoughts and efforts.

When at last, more than twenty years later, the National Archives building and establishment were assured, and Jameson had won the campaign which he had so long directed, he took advantage of the drafting of the Bill which became the National Archives Act of 19 June 1934, to include a provision creating the National Historical Publications Commission, as recommended by the "Assistant Committee" of a quarter of a century earlier. Thus the Association's action of 1907 resulted in action by Congress in 1934. The first years of the Historical Publications Commission were disappointing as to results. Their story is well told by Dr. Hamer in his Report to the Commission of 1951, which all members of the Association should read. This report followed the reactivation and reorganization of the Commission by the Federal Records Act of 5 September 1950, due in large part to the interest of President Truman which had been aroused by the publication of the first volume of the Jefferson papers.

The Commission is exceedingly fortunate in having as its executive secretary and director Dr. Philip M. Hamer whose very modest participation in this morning's session does not begin to tell the story of the energy and tact with which he is making the Commission into a central and effective agency for the development of a national, not merely a governmental program of historical publications. I cannot but feel that the spirit of Jameson and the spirits of his eight colleagues of the Association's original committee must have been with us in this session and must have felt that their efforts of nearly half a century ago are bearing the fruits for which they hoped.

# Art as the Function of an Audience

*Lecture given at the Fogg Museum, Cambridge, Mass.,  
on 18 November 1954*

JOHANNES A. GAERTNER

GRANT SHOWERMAN in his book *Eternal Rome*<sup>1</sup> mentions the fact that during the Dark Ages "inscriptions and statues, as well as the marble blocks of the larger monuments, found their way into the hands of lime-burners and marble-workers. The whole neighborhood of the Flaminian circus was known for its lime-kilns, and was called the Calcarario. Nearly every ruin of importance had its permanent or temporary kiln. The Forum Magnum and the imperial fora, the mausoleum of Augustus, the baths of Agrippa, the Julian basilica, the temple of Vesta, and many others were thus equipped. A kiln of unburned statuary, ready for firing, was discovered in the palace of Tiberius. Cords of statues awaiting conversion into lime were found in the precincts of the Vestals. On the floor of the Julian basilica alone there were two kilns." It goes without saying that by the time marble statues were burned to lime, metal statues, bronze ornaments, even the lead clamps between columnar drums and other stone work had been long since melted down.

Where a marble statue around A.D. 50 was considered a precious work of art, nine hundred years later that same statue was to the *entrepreneur* who had a concession to mine an ancient building nothing but a fine piece of crystallized limestone which, when burnt down, would yield a quantity of specially fine white chalky lime, since marble used for statuary scarcely contains any impurity. Where a bronze statue around 200 B.C. may not only have had an artistic, but even a religious value, the same statue eight hundred years later will be but a piece of metal to be melted down for a pot, for a pan, for the tip of an arrow.

We do not have to investigate the reasons for this astonishing transvaluation. Suffice it to say that epidemics, floods, barbarian invasions, economic and political disaster, religious and racial shifts had wrought a change where indeed a bit of metal, a pound of lime were more im-

<sup>1</sup>Grant Showerman, *Eternal Rome* (New Haven, 1925), p. 365.

portant for the pressing need of the moment than the most wondrous heathen goddess in all her marble beauty.

The point that interests us here, is not to find out why people had ceased to treat the ancient statues as works of art, let alone as venerable religious objects, but that they did so at one time, whatever the reasons, and that, after "a thousand years of ruin," during the Renaissance they again became what we shall subsequently call "an audience" in regard to these statues. Our example teaches us that a certain contrivance may be a work of art for one audience, cease to be it for another and again become a work of art for a third one.

Before we go on, let us define an audience as that part (group or individual) of a public which responds to the specific (aesthetic) stimulus of a work of art or of an artistic effort; in this sense a girl who reads *True Stories* or a group of people who see a movie or the visitors of a museum are an audience. We could go into finer distinctions at this point, for instance, between actual (people who appreciate) and potential (people who would appreciate) audiences, between direct (theatre) and indirect (cinema) audiences, but will forego these finer distinctions in the interest of brevity. Let me point out, however, that if English were not the linguistically old and therefore comparatively inflexible language it is, we might well speak of vidience (a looking audience), legience (a reading audience), etc. We understand now what was meant when we said that the marble statues of antiquity had lost their audience during the Dark Ages. At the same time we find that, in doing so, they had, at least temporarily, ceased to be art.

It comes with a shock for most of us to realize that without an audience there is no art.<sup>2</sup> There is only the artistic intent of the artist embodied in his work or effort which thus constitutes a stimulus, but there is no art unless that stimulus acts upon an audience. If Dante's work were offered to the Firelanders or Ainus or Australian aborigines who do not understand Italian, who would be incapable of learning it and who could not cope with abstract concepts, nothing of what he said or meant could ever be art to them.

Formulating then our basic observations into a series of axioms, we arrive at the following:

<sup>2</sup>Edgar H. Sturtevant, *An Introduction to Linguistic Science* (New Haven, 1947), p. 3. "A corollary of the final clauses of the definition is that a language cannot function normally unless there are at least two speakers of it. When only one speaker remains the language may be said to be dead."

(1) Art is not, it happens. What is and exists is only the work of art, the stimulus of an aesthetic reaction.

(2) The place where art happens (the locus of art) is the mind of an audience.

The work of art exists only as potential art, as a match exists only as a potential fire. Under certain conditions the match may become a fire, be consumed in a fire, but as long as the non-burning match exists, there is no fire.

(3) The work of art is a symbol, a stimulus, and a challenge.

There is no law to define anything by just one paraphrase. If in the exact sciences a thing can or must be defined in one way and one way only, that is just too bad and shows the spiritual poverty of pure science. In the *Geisteswissenschaften*, where we deal with ideas, a definition is the better, the richer and more manifold it is. And, of course, in contrast to the sciences it always admits exceptions.

(a) The work of art as a symbol. Susanne K. Langer has said enough about that. Though there have been artists who pretended a lack of desire to communicate, it was only because they felt no audience would be able or willing to understand their work. In the moment anyone, including our brothers behind the bars and padded walls of mental institutions, produces a symbol, a sign, a gesture, a whistle, he wants somebody else to understand it. Symbols are the coins of communication. Art is only a communication in which an artist through specific symbols communicates with an audience. This communication takes place in the mind of the audience. The audience may understand the symbol in the way the artist wanted it or not; as long as it is "challenged" in a specific aesthetic sense, art happens. It is only when the audience no longer responds aesthetically (as in the case of medieval lime-burners destroying ancient statuary) that art does not happen.

In our present-day much too intellectual approach to art great importance is being given to the understanding of the artistic symbol. Let me point out that, as in the case of religion, misunderstandings, misreadings, conscious or unconscious misinterpretations of the original message provide the most lovely occasions for art. We misunderstand nearly all Eastern art, nevertheless can enjoy it as art.

(b) The work of art as a stimulus. We use the word stimulus with great hesitation, because it smacks of psychology and we deal here with the higher, more humane and complex functions of man's mind and soul, to the understanding of which the absurd and strait-jacketed

academic psychology of our times unfortunately neither has made nor can make any valid contributions. Yet with all due caution — there simply is no other word and so we use the hateful term “stimulus.” A stimulus provokes a reaction. The reaction proves in our case to be a specific aesthetic delight. All that sounds pretty much like talk about Pavlov’s dog, yet there is some truth in it. Up to a certain point the mind’s reaction to the stimulus is automatic. It is this reaction which the artist also has in mind when he creates the artistic symbol.

Yet if we would let it go at that we would be guilty of a sin that sounds like a communistic reason for liquidation: psychologism. An ugly sin with an ugly name. There is more to the whole complex of art than a simple stimulus and reaction formula.

(c) The work of art as a challenge. When art happens, the mind of an audience, ultimately of course the mind of so and so many individuals, does not only simply react, but it does something actively on its own part. It is challenged. It creates art. This, of course, cannot be expressed in percentages. One cannot say that the artist and the audience are responsible for 50 per cent each, or anything of that kind. It is rather a process of creation, rather literally, whereby, if you want, the artist engenders art in the mind of his audience by means of the artistic symbol.

(Again, let us repeat: art happens like a fire. The work of art is like a match, potential art. The artist is the man who invents or provides the match.) Thus in the creation of art the artist’s role resembles more that of the father, that of the audience more that of the mother.

It is quite clear that

(4) the quality of art depends not only upon the quality of the work of art, but equally upon the quality of the audience. Great art demands not only the great work of art, but first and foremost the great audience. A great work of art in a poor audience produces little actual art or none; typical is the aged tourist who spent his life in the pursuit of money through the sale of life insurance and then suddenly is confronted with, say, the Moses of Michelangelo. This is a great work of art, yet it evokes no response: result—no art. The same man, however, may be touched to tears by a sentimental cover on the *Saturday Evening Post*, in which case art is being produced, although admittedly at an intellectually lower level.

Now art education aims to produce an ideal audience, an audience which is sensitive, appreciative, intelligently critical. This aim is achieved, or at least striven after, by teaching the rudiments of draw-

ing, music, writing, etc., by acquainting the young with acknowledged masterpieces and by giving them all sorts of pertinent historical, sometimes even philosophical and critical, data. All this, at best, does not much harm; it does not much good either. That is a strange statement in the mouth of one who makes a living by teaching art history and art appreciation. Am I sawing off the branch on which I am sitting? In a way I am. I wish it were not necessary to teach these things. Art appreciation has not to be taught where the audience has some intellectual eagerness and at least some awareness of existential values, such as greatness, nobility, etc.

(5) In art the whole person responds productively to the challenge of the work of art, not only that part which took Fine Arts I and II. If we were fully civilized, our education would provide and enforce intellectual discipline and existential greatness, at least in an elite (most people are incapable of either), yet since we cannot achieve that, at least half a civilization full of survey courses and easy introductions to the imitations of true culture is better than a full barbarism.

A great audience would be in possession of large tracts of our Western civilization, which would include the knowledge of Latin and Greek, ancient, medieval and some modern literature, the acquisition of a few foreign languages, folklore, mythology, Bible knowledge, religious tradition, travel, etc. Only such an audience can be called commensurate to the great works of art, only in it can art fully flourish again. One perceives immediately how far removed we are, individually and as a group, from living up to our greatest works of art. Yet even in the neo-Byzantine twilight of our Western civilization, let us by all means train the young, if we can no longer truly educate them, to show the proper reverence for that which they scarcely understand any more, or which we must make palatable to them through a system of complicated re-interpretations and conscious misunderstandings. We might say then in conclusion that

(6) the best education for art is simply education, which, if rightly performed, obviates all special art education.

We follow this dictum incidentally in the lower branches of art where nobody would ever think of educating anybody to follow the average television program, which, to be sure, is carefully held at a level accessible to anyone who understands English.

It might at this point be said that the higher pleasures of art are "sicklied o'er with the pale cast of thought" and that what the primitive mind loses in depth, it gains in intensity. These things are difficult

to judge, yet a few reflections on that point may not be amiss.

The response in art, as we said, is a total response. As such it is governed by that which a person knows, by his intelligence, life-experience and particular mode of being.

It is obvious that the poetry of T. S. Eliot means more to me, if I know Greek mythology, medieval legends, the traditions of the Church and ample amounts of history and world literature, than if I am ignorant of all these things.

It is less obvious that, aside from simple knowledge, a certain quickness of mind, a capacity for the spontaneous combination and juxtaposition of many facts, a quick grasp of complex situations and a ready memory are also needed.

Knowledge and intelligence, however, are not enough. Life experience also enters. One reads a book differently, if one knows its locale; one sees a battle photo with different eyes before and after one has been in a war.

Beyond knowledge, intelligence, life-experience, however, there looms the human personality as such. Two boys with equal education, of equal intelligence, and of very similar life-experience, will still exhibit wide differences in their modes of answering the artistic challenge. There is such a factor as human greatness, a factor which cannot be described, as love cannot be described, but must be experienced. (Yet the fact that a thing may neither be definable nor describable does not mean that the thing does not exist.) It takes a certain greatness in the audience to respond to greatness in the work of art.

An audience is defined by innumerable factors: its size, varying from one person to millions, its distance from the artist in time, space, mechanical interference, its composition according to sex, age, nationality, education, point in time, point in space, by the weather that surrounds it, mentally and physically, and by many other factors.

Is there such a thing as a special aesthetic sensitivity? No doubt there is, but it is overrated. Aesthetic sensitivity is to a high degree a function of a man's intelligence, education, and most of all of his cultural environment. In America women are supposed to have a higher aesthetic sensitivity; in many parts of Europe and Asia men have it. An American boy educated in France and living among cultured people there will presumably exhibit a higher aesthetic sensitivity than a French boy being educated in the United States and unconsciously accepting our funny prejudices as to the aesthetic inferiority of men.

This short and very incomplete analysis of what an audience is and how it reacts will let us understand that the question of depth and intensity of actual art (as contrasted to intended art in the artist and potential art in the work of art) can scarcely be answered. One may say, of course, that a retired diplomat savoring a page of Montaigne has a *deeper* appreciation than a young man observing the quiver of Jane Russell's bosom; that consequently the young man's aesthetic enjoyment is more *intense*. Yet the older man's enjoyment may be very keen, and unless we fall into the most nefarious psychologism (where such things are measured by sweat production and pulse reaction), we can define depth only as a simultaneous and quite delightful *Zusammenschau*, a viewing together of many implications contained in and provoked by the symbol, while intensity means being fully possessed by one's aesthetic reaction. The young man observing Jane Russell's bosom has probably only one thought, but he has this one to the exclusion of any other.

Great depth of actual art probably is always connected with considerable intensity. Intensity however can be absolutely without depth. Depth is not necessarily a function of intelligence or knowledge, it can be one of life-experience or mode of being.

As in so many other things, the most effective education towards art is not that taught consciously in schools or homes, but comes from the adoption of cultural mores. We are educated by our environment, by history — ultimately by the dead who are always with us. In the film *Seven Brides for Seven Brothers* a typically American sequence shows how a woman single-handed forces seven savage backwoodsmen into conformity with the mores of Western civilization. Woman is here the bearer of civilization subjugating man. In European literature woman appears ever so often as exactly the contrary, the earth-bound being which hampers man's ideal ascent towards sublime heights. If anyone tries to civilize anybody else, it is man lifting up woman. Such deep-seated assumptions and cultural conditions create a special predisposition, a will towards art that is widely different in diverse nations, places, times, social levels, etc. The festive expectancy, the will towards art, are not to be underestimated. The audience is always primed.

Yet, after all has been said about an audience that can be said in such a short time, one conclusion must be made which constitutes our first step towards a liberation from certain Romantic notions which still beset us. This conclusion is that

(7) the audience cannot be wrong.

Except where an audience has been violently prejudiced, or intimidated or bribed from the outset or where it is ruled by a clique or a political clique, the audience must be considered naive and innocent, willing to give or withhold applause or recognition, as it feels. If the artist does not succeed with his audience, be it only one snooty individual or one solid group of morons, he simply has not found the right audience or, what always hurts most, has misjudged it.

The situation prevailing for the last 200 years of the artist sulking and saying: my work is good but the audience is poor (and the public sometimes believing it), is nonsensical. The audience reacts as it must react according to the laws of its own being. One has found out that a group audience reacts more favorably to unusual music after lunch than before. The artist may think that this is as deplorable as the fact that an audience can be influenced by clever publicity; the point is that the audience cannot help liking strange music better after lunch or taking it rather from Rubinstein than from the kid next door who may play as well.

If an audience does not behave as the artist or art critic may want, it indicates only that the artist has not the right audience or that he misjudged it or that he simply cannot communicate well enough.

No artist can satisfy all people. What goes well with the crew-cut "gone and crazy" crowd, the real nervous cats, does not go for their fathers; what enchants people who read comics fails to enchant people who read books.

Is the approval of an audience, say the swoon of teen-agers when the current idol sings, or the applause of elderly ladies when Liberace plays schmaltz, a sign of artistic success? You bet it is! A film which earns five million dollars is better than one which earns only two. Is Liberace who draws crowds bigger than Billy Sunday did a greater artist than, say, Solomon or Malcuzyński? Not necessarily a greater, not even a better one, but certainly a very good one, because he engenders a vivid aesthetic enjoyment, art in other words, in an admittedly limited and specialized audience. Solomon would be a failure before Liberace's audience and *vice versa*. In America the possession of money and consequently the patronage of an artist no longer goes along educational lines. The big money may be with the low- and middle-brow market, while formerly the big remuneration in terms of fame and money lay with the educated: the court, the church, the nobility, *la haute bourgeoisie*.

Yet, admitting all that and knowing full well the historical reasons and their cultural implications, the fact remains that the audience is always right where it reacts without intimidation or bribery, because it does exactly what it is supposed to do: it reacts to a stimulus, it gives its own creative answer to a particular challenge.

By this time everybody will look at me with loathing as a man who defends low commercialism in art, who prefers Liberace to Rubinstein and who sees artistic success evidently entirely in terms of money. I hasten, therefore, to straighten out a few points that will bring me back into human society.

I do not defend commercialism in art, because all art (including the building of the Parthenon and the erection of Gothic cathedrals) has always been commercial as far as the artist was concerned. The artist made a living, sometimes even a very good living, by his art. Read Dürer, Cellini, Vasari—little is said about the titanic inner struggle, much about prices, patrons, sales, recognition in terms of fame and money. The normal artist wants to sell his stuff and get good money for it.<sup>3</sup> His disinterest in sales of his work or attendance at his recitals or circulation of his books is usually as genuine as the disinterest of a maiden in marriage. There have been cases, to be sure, where an artist could not find an audience (Van Gogh, the young Renoir, Blake) but that does not mean that he did not want to find one. Even in such cases the artist who at his most romantic was never so alienated from contemporary society as not to find a few bridges (otherwise he would have been insane), always had a public, only one which was too small and too poor to maintain him. Up to the times of eighteenth and nineteenth century Romanticism it was always understood that the audience knows what it likes and not the artist, that the artist works for the audience and not *vice versa*.<sup>4</sup> The greatest portrait painters of the

<sup>3</sup> Moses Hadas, *Ancilla to Classical Reading* (New York, 1954), p. 48. "Readers who attribute to the Greeks a pure cult of beauty are disconcerted to find that most of the poetry of the classical age was written on commission. Like the sculptor, the poet supplied a requirement of religion or patriotism or family loyalty or pride for pay, and without compromising his personal dignity or artistic integrity."

<sup>4</sup> The complex relationship between artist and audience has been treated with great philosophical insight by two artists, Franz Kafka and Isak Dinesen [Baroness Karen Blixen]. In *Josefine, die Sängerin, oder Das Volk der Mäuse* [in *Vor dem Gesetz* (Berlin, 1934), pp. 33-54, and elsewhere], Kafka dealt penetratingly and sarcastically with the pretensions of the romantic artist, and Isak Dinesen gave us that beautiful *Consolatory Tale* [in *Winter's Tales* (New York, 1942), pp. 287-

past always left as a matter of pride and prudence the ultimate decision about a portrait to the buyer. He had to take it, only if he, or more important, if she liked it. We have the same attitude still towards cooking. What we do not like, we do not eat, and when the cook assures us a hundred times that we are barbarians and that he alone knows what we ought to like, we shrug our shoulders and patronize another restaurant. Let us bury then the absurd Romantic notion that serious art could be anything but commercial. In fact the non-commercial aspects of art are exactly those of hobby and amateurism. The artist wants recognition (applause is a subtle form of payment) and the public expects and always has expected to pay the artist something. (In American radio the payment is the endurance of advertising.) Do I prefer Liberace to Rubinstein, Norman Rockwell to Andrew Wyeth, Edgar Guest to T. S. Eliot? Of course not, but then, I am a high-brow. There is no doubt that Liberace, Guest and Rockwell are successful artists, but I would not call them great artists. Greatness involves the production of work which is significant, at least potentially, on many levels. A picture like *Henry V* is a great picture because it contains at all times and organically through and through, not only alternately, additively, cumulatively, material to interest men and women, children and grownups, low morons and high sophisticates. Such a work is a great work of art, because Shakespeare is a great artist and so is Laurence Olivier. Liberace, Rockwell, Guest do exceedingly well by one audience and one audience only. Would under these circumstances the painter of nudes for coal company calendars and the painter of meaningless abstractions, both either impalatable for or inaccessible to the rest of the public (outside of their special audiences), be comparable? Yes, indeed. Both might be successful artists; neither would be a great artist, for he would lack the touchstone of greatness: universality. One is vulgar, the other one precious.

Having gone so far in the demolition of Romantic prejudices let us now drive the last nails into the coffin of the Romantic Artist as still conceived today.

(8) There never was, nor is, nor can there ever be a tragic separation between the artist and society.

When an artist, say the young Stravinsky playing *The Rites of Spring*, wherein the artist is compared to a beggar who, assumed to be a prince *incognito*, is forced to make curious sacrifices to maintain his ambiguous yet satisfying position.

*Spring* for the first time, experiences the applause of 20 people and the disapproval of the other 980 people in the concert hall, it means that he has an audience, but a very small one in whose mind his work engendered actual art; that the other 980 simply are not or not yet an audience for his work. Let us suppose 980 people had applauded and only 20 hissed, would Stravinsky have been happy? He certainly would! The phenomenon of mixed acceptance points to a stratification of the audience which is a social problem, not an aesthetic one. Audiences are not homogeneous and few artists have ever pleased all people; there always has been an art of the court, inaccessible to serfs and peasants, and an art of the peasants held in contempt by priest and courtier. If an artist can please all people, he is a great artist, like Shakespeare, who can combine a rousing good yarn with lovely poetry and profound philosophy so that everybody at all times finds in his work something delectable. That such a man commanded a wide audience and still does is not the result of happy social or political circumstances, but the result of overpowering genius. But, as I said, people like Shakespeare or Michelangelo or Beethoven whose works have a universal appeal, are rare. The ordinary artist must be content with a more limited audience.

When people today speak of the tragic separation of the artist from society, they repeat thereby simply certain Romantic clichés, flattering to the artist but without much foundation in fact. The artist is today no more separated from society than he ever was. Is Hollywood separated from society? The Romantic fallacy that the artist is or must be a lonely being (what Peter Altenberg called "a sick eagle") is explicable through a number of historical and sociological factors of which we shall mention a few.

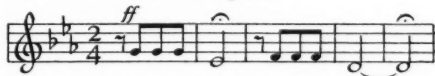
(a) Through the vast sociological changes that the Industrial Revolution brought, communication between the different levels and layers of society pretty much ceased for a time: worker and capitalist, old nobility and new wealth, the scientist and the priest, the exploiter and the exploited—all had little contact with each other; there was much friction but no understanding. What wonder then that the artist producing work which was accessible to one class only was shunned or misunderstood by another?

Yet, that was a perfectly normal situation which up to the nineteenth century had always been borne by the artists with the greatest equanimity. It was understood that different social classes would need different art. Why then the sudden resentment?

(b) Probably, because of such nebulous concepts as mankind or the common man or the folk, the equality of all people, of a romantic dream of the artist as a being able to speak to every single person in an entire nation—a wishful dream, if there ever was one. There have been in the past and there continue to be at present millions of Italians who don't know who Michelangelo was and couldn't care less. During the war Americans quizzed German soldiers—and mark you Germany was and is a well-schooled nation—and found vast numbers completely ignorant of people like Kant and Goethe. How many Americans know who Thomas Eakins was?

There are, as we said, works of art that are potentially so rich that they could satisfy any level of intelligence, knowledge or sensitivity. Experience shows however that the high-brow is much rather inclined to enjoy such a work than the low-brow who views things that might possibly be high-brow with much more suspicion. The enthusiasm for Shakespeare, though he would be a universal artist, is still a high-brow enthusiasm.

(c) The artist who complains about the rift between himself and the public is one who caters to a high-brow audience which in the nature of things must be small. If art critics complain that so few people like advanced stuff, they utter at best hypocritical nonsense. They would have to change human nature to improve the situation. "The average American," as a friend of mine overheard somebody saying, "The average American is below average." We might paraphrase this sentence by saying that the average man seems to be below average. If you want to communicate with him and have the necessary energy and talent, you will be able to do so, as Hollywood, TV and popular literature so impressively show. If you want to reach the exquisite minority, you have to be content to be appreciated by a few connoisseurs. To reach (in economical terms) the quality market of the high-brow and the financially more lucrative quantity market of the middle- and low-brow level is quite difficult, unless you are really an extraordinary genius who can produce a symbol so simple that it can be whistled and used as a signal



and so complicated that it satisfies the most sophisticated symphonic connoisseur. But, even so, chances are that the applause will come from the high-brow section.

(d) Finally: if what artists and art historians again and again insist on were true, namely that up to the end of the eighteenth century the artist lived happily in the bosom of society and thereafter was separated from it, then art should have ceased for certain classes during the nineteenth and twentieth centuries. But nothing of the sort happened: the workers always had their sentimental ballads and cheap music, the middle class had its more refined pleasures and the upper classes were deluged with the most exquisite works of art. No artist could be or ever was in intimate contact with all layers of society, but every artist given the necessary talent can find an audience, though not perhaps the one he wants or is capable of reaching.

And that brings us finally to the question of integrity. Integrity is the artist's insistence that the audience which he wants to reach must like his work the way he has created it. If the audience does not like it, the artist has several ways open to him: he can try to explain or he can wait for a shift in public taste or try to reach another audience (which is what most serious artists do and explains why they have to do something else to make a living—such things take time) or he may adjust his work to the taste of such audience as he can find, which idiotically enough most artists find degrading. They thus forego the rewards of the mass market for the pleasures of the quality market. Ultimately

(9) integrity means the rejection of one audience in favor of another—a privilege the artist has, but about which he ought not to complain.

We will conclude our deliberations with a consideration of the effects of our basic assumption, namely that actual art is something happening in the mind of an audience, on art history.

(10) Art history has largely been a history of intended art (that of the artist), of potential art (the work of art), but too little one of actual art (happening in the mind of an audience); in other words the work of art makes sense only when we know what audience the artist had in mind, what his actual audience was and how it did react.

That is a noble, gigantic and wholly impossible task. To reconstruct the mind of the Leipzig burghers who heard the *Passion of St. Matthew* for the first time and for whom it was written is incredibly difficult. Even if we could pretty much define the intellectual content of the mind of such an audience, there would be still the unknown factor of the emotional connotations of words, chords, melodies, etc. Ideally we should be aware of all that; practically we cannot.

Shall we then take the work of art of past ages chiefly as a con-

temporaneous work as the New Criticism has suggested? I feel that we can scarcely do anything else, being after all children of our own time first and foremost. We have not to be admonished to do so. Yet to leave out historical considerations boils down to misunderstanding the work intentionally or, let us say, re-interpreting it rashly. The historical contribution is necessary and desirable. It is here that the art critic and art historian come in, supplying the necessary background. Do I then favor poetry editions full of footnotes or people who run through museums with their noses in guide-books? No, but I love people who know *a priori* what the footnotes note and the guide-books say. The best education for art, to repeat what we said, is education, carried and enhanced, we might add, by a society which values the spirit, which respects intelligence and which fosters a sense of existential values. When I said that the artist is wrong in complaining about his audience or deploring the minute size of a high-level audience, I did not want to imply that as an audience with a sense of responsibility we can simply lean back.

We may be right as an audience whenever we feel innocently and directly what we feel, and respond to the artistic challenge naively and without reservations. Yet, the quality of our response is dependent upon our quality as human beings and it is here that we shall always fall short. We are open to constant growth and improvement, intellectually, ethically, aesthetically, existentially. The demand to grow until we become commensurate to them is the demand the great works of art put upon us. In fact, if we refuse their demand, the time may come again when we shall know no other way to deal with a marble statue but to burn it to lime.

## Records of Meetings

### 13 October 1954 — Stated Meeting

The One Thousand Three Hundred and Seventy-Sixth Meeting of the Academy convened at its House on 13 October 1954, and was called to order by the President at 8.15 P.M.

There were present 99 Fellows and 65 guests.

The records of the meeting of 12 May were approved as published.

The Secretary reported that the Council had approved six grants-in-aid from the Permanent Science Fund totalling \$7,030 and one grant of \$500 from the Rumford Fund.

The Secretary reported the following recommendations of the Council for amending the Statutes:

*Chapter I, Article 3:* The corporate seal of the Academy shall be as here depicted:

*Chapter IX, Article 2, (i):* Delete all except the following: "The Proceedings shall be published at least semi-annually."

*Chapter IX, Article 2, (iii):* Delete from the second line "eight times each year."

*Chapter IX, Article 3* should be changed to read: "A copy of the Proceedings and of the Bulletin shall be mailed to each Fellow, Fellow Emeritus, and Foreign Honorary Member."

Thirty-six recently elected Fellows were introduced as follows: Lawrence Bernhart Anderson (IV:4), Henry Beston (IV:4), William Weber Buechner (I:2), Lyman Henry Butterfield (IV:2), Bruce Chalmers (I:6), Karl Wolfgang Deutsch (III:3), Martin Deutsch (I:2), Charles Dollard (III:5), Dows Dunham (IV:2), Tilly Edinger (II:3), John King Fairbank (IV:2), Jacob Fine (II:5), Horace Rowan Gaither, Jr. (III:5), John Merriman Gaus (III:3), David Rockwell Goddard (II:2), Richard Hale Goodwin (II:2), George Maxim Anossov Hanfmann (IV:2), John Hartwell Harrison (II:5), Franz Joseph Ingelfinger (II:5), Milton Katz (III:4), Carl Kaysen (III:2), Francis Dean Keppel (III:1), Charles Poor Kindleberger (III:2), William Leonard Langer (IV:2), Henry Allen Moe (III:5), Philip Phillips (IV:2), Nathan Marsh Pusey (III:5), Denis Morrell Robinson (I:6), Jakob Rosenberg (IV:3), Rudolph Ruzicka (IV:4), William Gurdon Saltonstall (III:5), Heinrich Schneider (IV:3), Carl Wilhelm Wagner (I:6), Fletcher Guard Watson (III:1), Frank Henry Westheimer (I:3), Frederick Roelker Wulsin (III:1).

Communications on *Foundations in American Society and the World Today* were presented by:

H. Rowan Gaither, Jr., Director, Ford Foundation

Charles Dollard, President, Carnegie Corporation of New York

Milton Katz, Professor, Harvard Law School; formerly Associate Director, Ford Foundation

The meeting dissolved at 10.12 P.M.

10 November 1954 — Stated Meeting

The One Thousand Three Hundred and Seventy-Seventh Meeting of the Academy convened at its House on 10 November 1954, and was called to order by Vice President Canham at 8.20 P.M.

There were present 57 Fellows and 49 guests.

The records of the meeting of 13 October were read and approved.

The Secretary reported the following announcements from the Council meeting this evening. The Academy has received a grant of \$22,000 for a two-year period in support of a study of "The Acceptance of Scientific Theories" to be carried on under the direction of Dr. Philipp G. Frank. Dr. Frank's office for this project will be on the fourth floor of the Academy's House. Upon recommendation by a special committee on the 250th anniversary of Benjamin Franklin in 1956, the Council approved publication by the Academy of facsimile copies of those parts of the *New England Courant* with which Benjamin Franklin is closely associated. The Council was authorized to use the title *Dædalus* as an added title in conjunction with the publication of the *Proceedings*, under a new policy proposed by the Committee on Publication.

The amendments to the Statutes as proposed at the October meeting and as published in the November issue of the *Bulletin* were adopted without opposition as follows:

*Chapter I, Article 3:* The Corporate Seal of the Academy shall be as here depicted.



*Chapter IX, Article 2 (i):* "The Proceedings shall be published at least semi-annually."

*Chapter IX, Article 2, (iii):* "The Bulletin of the American Academy of Arts and Sciences shall be published preceding the stated meetings, containing notice of such meetings, communications from the Council or Officers, and such other matter as may be of timely interest to the Fellows."

*Chapter IX, Article 3:* "A copy of the Proceedings and of the Bulletin shall be mailed to each Fellow, Fellow Emeritus, and Foreign Honorary Member."

Five recently elected Fellows were introduced as follows: Henry Ives Baldwin (II:2), Dean Alexander Clark (III:5), Albert Hewett Coons (II:2), George Leslie Stout (IV:4), Charles Gardner Swain (I:3).

A symposium on *Tracer Applications of Radioactive Isotopes in Biology and Medicine* was presented by:

Dr. Edwin B. Astwood, Professor of Medicine at Tufts Medical School

Dr. John F. Buchanan, Professor of Biochemistry at Massachusetts Institute of Technology

Dr. Joseph F. Ross, Professor of Medicine at the University of California at Los Angeles

Dr. Arthur K. Solomon, Assistant Professor of Physiological Chemistry at the Harvard Medical School

The meeting was dissolved at 10.07 P.M.

### 8 December 1954 — Stated Meeting

The One Thousand Three Hundred and Seventy-Eighth Meeting of the Academy convened at its House on 8 December 1954, and was called to order by President Burchard at 8.20 P.M.

There were present 60 Fellows and 63 guests.

The records of the meeting of 10 November were read and approved.

Mr. Wald, Chairman of the Rumford Committee, announced that the Council this evening had approved the recommendation of the Rumford Committee to present the 1955 Rumford Premium to James Franck of the University of Chicago, for his fundamental studies on the mechanism of photosynthesis. The award of the Premium was given for Dr. Franck's work since he came to America.

Seven recently elected Fellows were introduced as follows: Eric Alfred Havelock (IV:3), Patrick Mason Hurley (I:5), Barbara Wharton Low (II:1), Millard Meiss (IV:3), William Edward Moffitt (I:3), Thomas Willoughby Nason (IV:4), Robert Treat Paine, Jr. (IV:4).

The following communication was presented:

Jakob Rosenberg: *Rembrandt the Draughtsman (with consideration of the problem of authenticity)*. This will be printed in the next issue of *Dædalus*.

The meeting was dissolved at 9.50 P.M.

### 12 January 1955 — Stated Meeting

The One Thousand Three Hundred and Seventy-Ninth Meeting of the Academy convened at its House on 12 January 1955, and was called to order by President Burchard at 8.14 P.M.

There were present 79 Fellows and 91 guests.

The records of the meeting of 8 December were read and approved.

The Secretary reported that all Fellows elected last May have now accepted election with one exception. He reported that the last acceptance to come in was from Foreign Honorary Member, Albert Schweitzer, whose interesting letter of acceptance was read. The Secretary then commented that Friday would be Dr. Schweitzer's eightieth birthday whereupon the Academy arose to acclaim Dr. Schweitzer's acceptance; and it was directed that the President cable him birthday greetings.

The Secretary reported that the Council at its meeting on 22 December voted to present to the Academy for its approval the Council's suggestion that the Academy go on record as approving in principle, but not necessarily in any details, the proposal before the Massachusetts legislature seeking to preserve the historical architecture of a section of Boston from the State House westerly down Beacon Hill. The motion of the Council was approved.

Four recently elected Fellows were introduced as follows: Frederick Baldwin Adams, Jr. (III:5), Cyril Norman Hugh Long (II:4), Ernst Mayr (II:3), and Robert Rakes Shrock (I:5).

The following communication was presented:

Donald H. Menzel: *The Sun and the Earth*.

The meeting was dissolved at 9.45 P.M.

## 9 February 1955 — Stated Meeting

The One Thousand Three Hundred and Eightieth Meeting of the Academy convened at its House on 9 February 1955, and was called to order by President Burchard at 8.17 P.M.

There were present 56 Fellows and 60 guests.

The records of the meeting of 12 January were read and approved.

The Secretary announced that the Council had named Mr. Herbert Bloch to serve as Councillor representing Class IV, Section 2 in place of Hugh O'N. Hencken who had resigned this position in the Council. He also reported that the Council had granted a request of Mr. Sanborn C. Brown to use an Academy photograph in an effort to recover information concerning certain drawings by Count Rumford.

Two recently elected Fellows were introduced as follows: John Richard Pappenheimer (II:4) and William Herbert Sweet (II:5).

The following communication was presented:

Max F. Millikan and Wilfred Malenbaum: *Indian Economic Growth and United States Foreign Policy*.

The meeting was dissolved at 10.15 P.M.

## 9 March 1955 — Stated Meeting

The One Thousand Three Hundred and Eighty-First Meeting of the Academy convened at its House on 9 March 1955, and was called to order by President Burchard at 8.27 P.M.

There were present 87 Fellows and 70 guests.

The records of the meeting of 9 February were read and approved.

The Secretary reported that the Council at its meeting today approved fifteen grants totalling \$12,424 from the Permanent Science Fund, one grant of \$200 from the American Association for the Advancement of Science, Academy Research Grants in New England, and three grants totalling \$3,250 from the Rumford Fund.

The Secretary reported further that the Council had approved a tentative budget for the fiscal year beginning 1 April 1955 totalling \$36,730 from the General Funds. The Council also approved application to the National Science Foundation for a grant of \$10,700 to be administered by the Academy in conjunction with its hospitality to the International Optical Congress in the spring of 1956, primarily to cover the travel of scientists from outside the United States.

The President announced that the exhibit of Count Rumford's work

on the problem of photosynthesis displayed in the Lobby had been prepared by Mr. Sanborn C. Brown.

The President reported that the Council at its meeting today voted to sell the Academy's property at 28 Newbury Street, and he invited members of the Academy interested in details of the move to hear reports by members of the Council at the end of the meeting. It was reported that the Council voted that the proceeds from the sale of the House be carried in an account of the Academy to be known as the Agassiz Fund and that, when a permanent home is attained, suitable recognition of the Agassiz name be given.

The following Fellow was introduced: Richard D. Brauer (I:1).

Mr. Wald, Chairman of the Rumford Committee, introduced the Rumford Medalist for 1955 — James Franck. The gold and silver medals for his fundamental studies on photosynthesis were presented by the President.

The following communication was presented:

James Franck: *Physical Problems of Photosynthesis* [printed on pages 17-42 of this number of *Dædalus*].

The meeting was dissolved at 10.04 P.M.

WILLIAM C. GREENE, *Secretary*

## Documents

*From time to time the Editor proposes to print in this section documents that throw light upon the history of the Academy. The following letters accepting election, although one hundred and seventy-three years apart, require no further comment.*

### I

New Windsor Mar 22. 1781

SIR,

I am much indebted to you for announcing my election as a member of the American Academy of Arts & Sciences—I feel myself particularly honored by this relation to a Society whose efforts to promote useful knowledge will, I am persuaded, acquire them a high reputation in the literary world.

I entreat you to present my warmest acknowledgement to that respectable body and to assure them that I shall with zeal embrace every opportunity of seconding their laudable views and manifesting the exalted sense I have of the institution.

The Arts & Sciences essential to the prosperity of the State & to the ornament & happiness of human life have a primary claim to the encouragement of every lover of his Country & Mankind.

For the polite & flattering terms in which you have been pleased to convey the sentiments of the Academy I beg you to accept my grateful thanks and the assurance of my being with great esteem & respect

Sir

Your Most Obedient & Obligated  
Servant

G. WASHINGTON

The Reverend  
Joseph Willard.

## II

Docteur Albert Schweitzer, Lambaréné, Gabon Afrique, Equatoriale Française. Sur le bateau Général Leclerc en route de Bordeaux à Lambaréné 15 dec. 1954.

American Academy of Arts and Sciences  
28 Newbury Street, Boston 16.  
M. William C. Greene, Secretary

TRÈS HONORÉ M. LE SECRÉTAIRE

J'ai reçu votre lettre du 8 mai 1954, avec un retard de plusieurs semaines parcequ'il a fallu me la faire suivre: j'ai reçu votre lettre du 15 novembre 1954 et je viens humblement m'excuser de répondre si tard. Je suis si fatigué et j'ai un tel travail à faire pour mon hôpital, pour des manuscrits à terminer, qu'il arrive des époques, où ma correspondance devient un chaos dans lequel je ne me retrouve plus et dont je ne m'occupe plus. Je n'ai plus la force approchant des 80 ans de faire le travail que je dois faire. Alors je néglige une partie, et cette partie c'est ordinairement la correspondance. Des infirmières qui m'aident dans leurs heures libres comme secrétaires peuvent répondre à une partie des lettres. Mais un plus grand nombre je devrais répondre moi-même. Les époques les plus dangereuses pour la correspondance sont celles où je vais de Lambaréné en Europe ou d'Europe à Lambaréné. Car alors il y a à emballer, à déballer, à régler la vie d'une façon nouvelle. Je n'essaie pas de vous expliquer la vie que je mène. Je vous dis seulement, que je n'ai pas eu un seul jour de vacances pendant au moins 15 ans, jamais un dimanche. . . . A présent je me rends d'Europe à Lambaréné. Depuis le second jour d'embarquement je suis assis du matin au soir dans ma cabine, à mendre connaissance de lettres que j'aurais dû lire depuis des mois, si le temps, la fatigue, le travail et surtout l'état de mes yeux surmenés me l'avait permis. Et parmi les lettres extrêmement pressantes j'ai classé les vôtres. Et me voici assis dans ma cabine à vous écrire, pour vous confesser ma honte de vous avoir laissé sans réponse quoique l'honneur que vous m'avez fait en me nommant membre honoraire étranger de votre Académie m'ait profondément impressionné. La crampe des écrivains dont je souffre beaucoup ne me permet pas de vous écrire comme je devrais et le voudrais pour vous exposer mon cas. Je vous avoue que je n'avais pas remarqué le passage que je perdais le grade que vous m'aviez conféré, si je n'avais pas répondu à une date précise. L'essentiel pour moi est de

vous faire comprendre que j'ai été profondément sensible au grand honneur que vous m'avez fait et que, si je ne vous ai pas répondu comme le respect à votre Académie et mon coeur le commandaient c'était parce que les circonstances particulières de ma vie si compliquée et si dure ne me le permettaient pas. J'ai déjà écrit d'autres lettres d'excuses dans le genre de celle-ci dans le courant des dernières années. Mais aucune ne m'a paru aussi difficile que celle-ci.

Si donc vous devez appliquer votre règlement à un vieillard écrasé par le travail, je tiens à vous avoir dit par ces lignes, que je vous garde une grande reconnaissance d'avoir voulu me créer membre d'honneur de votre Académie si célèbre et vénérable. Veuillez me le faire savoir. Je vous renverrai alors le document de ma nomination et les feuilles que j'aurais dû remplir, si elle était restée effective.

Si vous croyez pouvoir faire une exception pour le vieillard écrasé par le travail que je suis, vivant dans une situation humaine exceptionnelle, veuillez me le faire savoir et je vous enverrai remplies les feuilles que j'ai à vous faire parvenir dans ce cas.

Je vous prie, monsieur le Secrétaire d'agréer l'assurance de mes sentiments les meilleurs et de la transmettre à Messieurs les membres de la vénérable Académie.

Votre dévoué

ALBERT SCHWEITZER

Mon adresse est: Lambaréné, Gabon, Afrique Equatoriale Française. Veuillez m'envoyer votre lettre par Air Mail. Si elle est envoyée par courrier ordinaire, elle met six semaines ou plus pour arriver.

## III

Docteur Albert Schweitzer, Lambaréné, Gabon, Afrique Equatoriale Française

28. janvier 1955

The American Academy of Arts and Sciences  
Monsieur William C. Greene, Secretary  
28 Newbury Street, Boston 16 Massachusetts. USA.

MONSIEUR LE SECRÉTAIRE

A ma grande joie j'ai reçu le 21 janvier le diplôme de Foreign Honorary Member de American Academy of Arts and Sciences. Je suis touché que vous ayez été indulgent pour le pauvre être noyé dans le travail que je suis. Laissez-moi vous exprimer toute ma reconnaissance. C'est une grande satisfaction pour moi, d'être de cette façon en relation avec cette vénérable Academy. Je voudrais pouvoir vous dire, que je me réjouis de venir à Boston pour me présenter à vous et faire votre connaissance. Hélas, je ne sais pas quand je pourrai revenir en USA. Ma vie devient plus difficile d'année en année. Mon travail augmente d'année en année. Je ne puis plus guère entreprendre des voyages que je voudrais, faute de temps disponible. Je me suis fait à cette vie. Mais quand j'entre en relation avec une Société comme la vôtre, je souffre de ne pas pouvoir faire la connaissance de ses membres. Voici quelques années que je suis membre de l'Academy de Vienne, où j'ai beaucoup d'amis. Je n'ai pas encore réussi à faire le voyage relativement petit de Strasbourg à Vienne. . . . Il faut que je me résigne. Mais il faut aussi que je me rende compte, que j'ai le grand privilège de pouvoir encore fournir du travail. Croyez-bien que je vous appartiens en pensée et que je suis heureux de pouvoir me rendre compte des travaux de votre Academy, si vous voulez bien me faire parvenir des Comptes-Rendus. Veuillez présenter mes respects à M. le Président et M. le Vice-Président et me croire

votre dévoué

ALBERT SCHWEITZER

